DATA SHEET

N1000A DCA-X

Wide Bandwidth Oscilloscope Mainframe and Modules

The N1000A DCA-X performs precision measurements on high speed digital designs from 50 MBd to more than 80 GBd on up to 16 channels simultaneously. Applications include optical transceiver design and production test, electrical ASIC/FPGA/IC design and characterization, serial bus characterization, and measurements and trouble-shooting via TDR/TDT and S-parameter measurements of channels, cables and PCBs.

KEYSIGHT TECHNOLOGIES

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Introduction

Keysight offers complete Digital Communication Analyzer solutions that can be combined with or used alongside the DCA-X, including clock recovery, stand-alone Digital Communication Analyzers (DCA-M) and software. For complete information on Keysight's entire DCA family, please refer to these other helpful documents:

- Keysight DCA Wide Bandwidth Oscilloscope Family Brochure
- Keysight DCA Family FlexDCA Sampling Oscilloscope Software Technical Overview
- Keysight N1000A DCA Wide Bandwidth Oscilloscope Family Configuration Guide, 5992-0038EN
- Keysight DCA Family Clock Data Recovery Solutions Data Sheet, 5991-2340EN
- Keysight N1090A, N1092A/B/C/D/E and N1094A/B DCA-M Optical and Electrical Sampling Oscilloscope Data Sheet, 5992-1454EN.

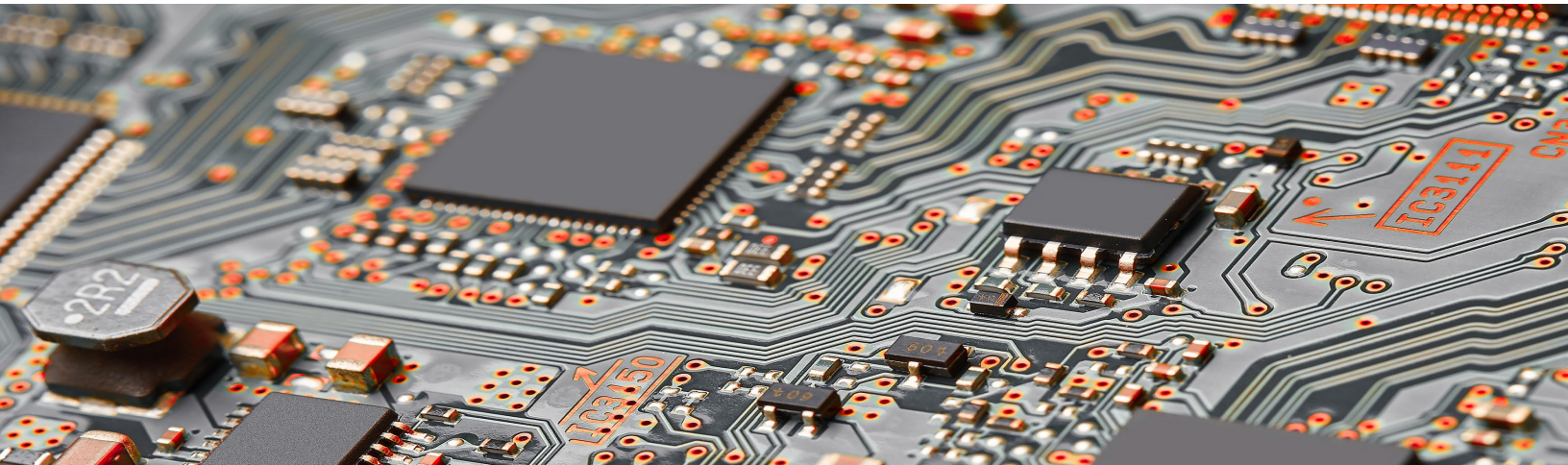
User Interface

The N1000A user interface and operating system is identical to the FlexDCA interface of the DCA-M modules (over a simple USB 2.0 or 3.0 connection) and N1010A FlexDCA on a PC.

Optical + Electrical and Electrical Clock Recovery

Optical + Electrical DCA-M

FlexDCA Software



N1000A DCA-X Specifications

General notes

NOTE: All specifications describe warranted performance over the temperature range +10°C to + 40°C (unless otherwise noted). The specifications are applicable after the temperature is stabilized, which occurs after 1 hour of continuous operation in final setup configuration and while self calibration is valid. Many performance parameters are enhanced through frequent, simple user calibrations.

NOTE: Specifications describe warranted performance. Characteristics provide useful, nonwarranted information about the functions and performance of the instrument. Characteristics are printed in green italics.

NOTE: Factory Calibration Cycle. For optimum performance, the instrument should have a complete verification of specifications once every 12 months.

NOTE: Nominal Value indicates the expected, but not warranted, value of the parameter.

N1000A computer system and storage specifications

Item	Description
CPU	Intel I5 Quad Core
RAM	8 GB
Operating System	Windows 10, 64 bit
Mass Storage	240 GB internal SSD hard disk

N1000A display specifications

Item	Description
Display Area	210.4 mm x 157.8 mm 10.4 inch diagolnal color active matrix LCD module incorporating amorphous silicon TFTs.
Entire Display Resolution	1024 pixels horizontally x 768 pixels vertically
Waveform Colors	Select from over 16 colors. User may change color assignment of all traces (channels, waveform memory, and signal processing functions).
Persistence Modes	Gray scale, color grade, infinite, variable
Connect-the-dots	On/Off selectable
Persistence	Minimum, variable (100 ms to 40s), infinite
Graticule	On/Off
Grid Intensity	0 to 100%
Dialog Boxes	Opaque or transparent
Supports External Display	Supports multiple display configurations via Windows display utility.

N1000A environmental specifications

Item	Description
Use	indoor
Temperature	
Operating	10°C to +40°C (50°F to +104°F)
Non-operating	–40°C to +70°C (–40°F to +158°F)
Altitude (Operating)	Up to 4,600 meters (15,000 ft)
Humidity [1]	Type tested at 95%, +40°C (non-condensing)
Line Power	100/120Vac 50/60/400 Hz
	220/240Vac 50/60 Hz
	700 Watts Maximum
	The products can operate with mains supply voltage fluctuations up to ±10% of the nominal voltage.
Weight	
Mainframe without modules (characteristic)	20.5 kg (43 lb)
Module (characteristic)	1.2 kg (2.6 lb)
Dimensions (excluding handle)	
Without front connectors and rear feet	221 mm H x 426 mm W x 530 mm D (8.7 inch x 16.76 inch x 20.9 inch)
With front connectors and rear feet	234 mm H x 426 mm W x 601 mm D (9.23 inch x 16.76 inch x 23.67 inch)
With front cover and rear feet	234 mm H x 426 mm W x 612 mm D (9.23 inch x 16.76 inch x 24.1 inch)

1. Samples of this product have been type tested in accordance with the Keysight Environmental Test Manual and verified to be robust against the environmental stresses of Storage, Transportation and End-use; those stresses include but are not limited to temperature, humidity, shock, vibration, altitude and power line conditions. Test Methods are aligned with IEC 60068-2 and levels are similar to MIL-PRF-28800F Class 3.

N1000A horizontal (timebase) specifications

Item	Description
Scale Factor	Full scale is ten divisions.
Minimum	100 fs/div
Maximum	50 ms/div
Delay	Time offset relative to the front panel trigger input on the instrument mainframe.
Minimum	16 ns
Maximum	1s
Time Interval Accuracy	1 ps + 1% of Δ time interval for intervals from minimum delay to minimum delay + 1 ns [1], *or* 6 ps + 1% of Δ time interval [1]
	500 fs + 0.25% of Δ time interval (characteristic) [2]
Time Interval Accuracy (Pattern Lock Mode)	1 GHz to 32 GHz: 500 fs + 0.5% of 1 / (clock input frequency), *or* 5 ps (whichever is smaller) [1]
	50 MHz to 1 GHz: 500 fs + 0.5% of 1 / (clock input frequency), *or* 30 ps (whichever is smaller) [1]
	250 fs + 0.25% of 1 / (clock input frequency) (characteristic) [2]
Jitter Mode Operation	Time interval accuracy – jitter mode operation 500 fs (characteristic). Test configuration: PRBS of length 2^7–1 bits, Data and Clock 10 Gb/s.
Time Interval Resolution [3]	(screen diameter)/(record length) or 60 fs, whichever is larger
Display Units	Unit Interval or Time
Record length	
Without Pattern Lock	2 to 128k samples/waveform in increments of 1.
With Pattern Lock	2 to 256M samples/waveform in increments of 1. [4]

1. Dual marker measurement performed at a temperature within ±5° C of horizontal calibration temperature.
2. Dual marker measurement performed at a temperature within ±1.5° C of horizontal calibration temperature.
3. The time interval resolution is the smallest time you can characterize between two points.
4. Maximum number of samples depends on pattern, number of active channels, available memory, pattern lock enabled, and *Acquire Entire Pattern* enabled.

N1000A front-panel inputs and outputs specifications

Item	Description
Trigger Input, Connector	2.92 mm (male) Mainframe ships with 2.92 mm female-female connector saver (P/N 1250-4105)
Trigger Input, Impedance (Normalized)	50Ω
Trigger Input, Maximum	2 Vpp maximum
Precision Timebase Input, Connector *(Option N1000A-PTB only)*	2.92 mm (male) Mainframe ships with 2.92 mm female-female connector saver (P/N 1250-4105).
Precision Timebase Input, Impedance (Normalized) *(Option N1000A-PTB only)*	50Ω
Precision Timebase Input, Maximum *(Option N1000A-PTB only)*	1.3 Vpp maximum
DC Cal Output	BNC (female) Range: –2.0V to +2.0V
USB	Three USB 2.0 ports
Ground Connection	Banana plug

N1000A rear-panel inputs and outputs specifications

Item	Description
GPIB	Fully programmable, complies with IEEE 488.2
Display Port	For connecting external displays
VGA Port	Analog, full color, 15 pin D-sub (female)
LAN	Two Gigabit Ethernet ports
USB	Two USB 3.0 ports Two USB 2.0 ports
USB Device Port	Instrument control over USB
Audio Ports	Audio IN (blue connection) Audio OUT (green connection) Microphone IN (pink connection)

N1000A internal precision timebase specifications (Option PTB)

The *N1000A Internal Precision Timebase Specifications* are for Option PTB, which is the N1000A internal precision timebase. These specifications refer to the signal input to the front-panel **Precision Timebase Input** connector.

NOTE: If **Freerun** trigger mode is *not* used, a trigger input *must* also be supplied. This is in addition to the reference clock input to the front-panel **Precision Timebase** connector. The trigger input must be synchronous to the reference clock but may be a sub-rate of the clock based on the required frequency range for the trigger input.

Item	Description
Maximum Input Signal	1.3 Vpp
Input DC Offset Range	± 200 mV
Input Signal Type The internal precision timebase works with typical digital clock signals, such as a BERT output, as well as sine waves. If the rise time or fall time of the clock signal is less than 15% of the period of the clock (for example, less than 15 ps for a 10 GHz clock), reduce the edge speed by using an external low-pass filter or length of cable. For the lowest jitter, use a signal that is as close as possible to the maximum signal amplitude (1.3 Vpp) and minimize any sub-harmonics.	
Jitter (Input ≥ 750 mVpp, sinusoidal) (Characteristic)	
2.4 GHz to <4.0 GHz trigger (tested at 2.4 GHz, 750 mVpp)	≤ 200 fs rms < 400 fs rms, with 54XXX, 8348X, or N1045A *(non Option LOJ)* module
4 GHz to 9.0 GHz trigger (tested at 5 GHz, 750 mVpp)	≤ 120 fs rms < 400 fs rms, with 54XXX, 8348X, or N1045A *(non Option LOJ)* module
>9.0 GHz to 44.0 GHz trigger (tested at 10, 20, and 40 GHz, 500 mVpp)	≤ 90 fs rms < 200 fs rms, with 54XXX, 8348X, or N1045A *(non Option LOJ)* module
Precision Timebase Input	
Nominal Impedance	50Ω
Connector Type	2.92 mm (male)

N1000A general trigger specifications

Item	Description
Maximum Trigger Signal	2V peak-to-peak
Trigger Input	
Nominal Impedance	50Ω
Reflection	10% for 100 ps rise time
Connector Type	2.92 mm (male)

N1000A internal trigger mode specifications

Item	Description
Freerun	Freerun trigger mode internally generates an asynchronous trigger that allows viewing the sampled signal amplitude without an external trigger signal but provides no timing information. Freerun is useful in troubleshooting external trigger problems.

N1000A clock trigger/pattern lock mode specifications

Item	Description [1]
Clock Trigger	50 MHz to 32 GHz, effective divide-by-one, AC coupled
Pattern Lock (Option PLK)	50 MHz to 32 GHz, AC coupled
Pattern Lock Length (Option PLK)	1 to 2^{23} (8,388,608) symbols
Jitter	
50 MHz to < 500 MHz	1.0 ps rms + 10 PPM of horizontal position (maximum) <800 fs rms + 5 PPM of horizontal position *(typical)*
500 MHz to 32 GHz [2,3] (Option STB)	450 fs rms (maximum) 400 fs *rms (typical)*
500 MHz to 32 GHz [2,3] (Option LOJ)	250 fs rms (maximum) 200 fs *rms (typical)*
Trigger Sensitivity	200 mV p-p
Trigger Slew rate	≥ 2V/ns

1. These specifications refer to the signal input to the front-panel **Trigger Input** connector. The sampled input signal timing is recreated by using an externally supplied trigger signal that is synchronous with the sampled signal input.
2. Verified at 10 GHz with a clock and signal slew rate ≥ 15V/ns.
3. Verified at 28 GHz with a clock and signal slew rate ≥ 20V/ns.

N1000A edge trigger mode specifications

Item	Description [1]
Input	DC to 2.5 GHz
Jitter [2]	1.0 ps rms + 10 PPM horizontal position (maximum) <800 fs rms + 5 PPM horizontal position (characteristic)
Trigger Sensitivity	200 mV p-p (sinusoidal input or 200 ps minimum pulse width)
Triggering Level Adjustment	–1V to +1V
Edge Select	Positive or negative

1. These specifications refer to the signal input to the front-panel **Trigger Input** connector. The sampled input signal timing is recreated by using an externally supplied trigger signal that is synchronous with the sampled signal input.
2. Verified at 2.5 GHz with a clock and signal slew rate ≥ 2V/ns.

N1000A vertical (channel) specifications

Item	Description
Sample Rate	Up to 250 kHz
Number of Channels	Up to 16 channels
Vertical Resolution	16 bit hardware A/D converter for N10xx-series modules. 14 bit hardware A/D converter for 861xx, 54xxx, and 8348x-series modules.
Full Resolution Channel Scales	Adjusts in a 1-2-5-10 sequence for coarse adjustment or fine adjustment resolution from the front panel knob.
Adjustments	Scale, offset, activate filter, sampler bandwidth, attenuation factor, transducer conversion factors

Module Selection Guides

Optical/electrical modules

Module	Option	No. of electrical channels	Highest electrical bandwidth (GHz)	No. of optical channels	Wavelength range (nm)	Unfiltered optical bandwidth (GHz)	Fiber input (µm)
N1030A		0		1	1250 - 1600	65	9/125
	EC1	1	95	1	1250 - 1600	65	9/125
N1030B		0		2	1250 - 1600	65	9/125
86105C	100	1	20	1	750 - 1650	8.5	62.5/125
	200	1	20	1	750 - 1650	8.5	62.5/125
	300	1	20	1	750 - 1650	8.5	62.5/125
86105D	141	1	35	1	750 - 1650	20	62.5/125
	281	1	50	1	750 - 1650	34	62.5/125
86115D	002/102/142	0		2	750 - 1650	20	62.5/125
	206/282	0		2	750 - 1650	34	62.5/125
86116C	25	1	80	1	1300 - 1620	40	9/125
	41	1	80	1	1300 - 1620	65	9/125

Available optical reference filter rates for optical modules

Module	Option	NRZ < 10 Gb/s	NRZ 10 Gb/s - 14 Gb/s	NRZ 20 Gb/s - 28 Gb/s	NRZ 39 Gb/s - 43 Gb/s	PAM4 26 Gb/s (with option IRC)	PAM4 53 Gb/s (with option IRC)
86105C	100	•					
	200		•				
	300	•	•				
86105D	141		•				
	281			•		•	•
86115D	002/102/142		•				
	206/282			•		•	•
86116C	25			•		•	•
	41				•		•
N1030A				•		•	•
N1030B				•		•	•

Electrical modules

Module	Option	No. of electrical channels	Highest Electrical bandwidth (GHz)	Step Generator (TDR)
54754A		2	18	2
N1040A	033	2	33	
	060	2	60	
N1045B	02x	2	60	
	04x	4	60	
N1046A	71F	1	75	
	72F	2	75	
	74F	4	75	
	81F	1	85	
	82F	2	85	
	84F	4	85	
	11F	1	100	
	12F	2	100	
	14F	4	100	
N1055A	32x	2	35	2
	34x	4	35	4
	52x	2	50	2
	54x	4	50	4
N1060A	050	2	50	
	085	2	85	

Module SIRC Filters

System Impulse Response Correction (SIRC) filters provide channel SIRC measurement and data files to give an ideal channel response. SIRC data can be applied in FlexDCA's System Impulse Response Correction dialog. The SIRC correction data feature is a digital filter that is used to:

- Improve the response of module reference filters to more closely match an ideal receiver.
- Enable non-standard reference receiver rates or bandwidths.
- Increase the bandwidth of the channel by up to 50%.
- Ensures that an eye diagram will look identical between different modules.

SIRC correction data is unique to a specific 86116C's serial number. The data can be purchased with new modules or purchased separately for your existing modules. Purchasing data for an existing module requires that the module be returned to Keysight Technologies. SIRC data is downloaded from Keysight.com. To order SIRC data, contact your Keysight representative or visit http://www.keysight.com/Find/FlexDCA.

NOTE: The SIRC filter ranges shown in the following tables are only available with option IRC and compliance is not guaranteed.

86105D SIRC filter ranges

Module/Option	Channel	Range[1]	
		Min SIRC Freq.	Max SIRC Freq.
86105D	Optical	4.98 GBd (3.73 GHz)	30 GBd (22.5 GHz)
86105D Option 281	Optical	7.5 GBd (5.63 GHz)	51 GBd (38.3 GHz)

[1] Only available with option IRC and compliance not guaranteed.

86115D SIRC filter ranges

Module/Option	Channel	Range[1]	
		Min SIRC Freq.	Max SIRC Freq.
86115D	All	4.98 GBd (3.73 GHz)	30 GBd (22.5 GHz)
86115D Option 282	All	7.5 GBd (5.63 GHz)	51 GBd (38.3 GHz)

[1] Only available with option IRC and compliance not guaranteed.

86116C SIRC filter ranges

Module/Option	Channel	Range[1]	
		Min SIRC Freq.	Max SIRC Freq.
86116C Option 025	Optical	8.5 GBd (6.34 GHz)	63 GBd (47.25 GHz)
86116C Option 041	Optical	19.91 GBd (14.94 GHz)	97.5 GBd (73.13 GHz)

[1] Only available with option IRC and compliance not guaranteed.

N1030A/B SIRC filter ranges

Module/Option	Channel	Range[1]	
		Min SIRC Freq.	Max SIRC Freq.
N1030A Option 560	All Optical	21.5 GBd (16.13 GHz)	80 GBd (60 GHz)
N1030A Options 280 *and* 560	All Optical	15.6 GBd (11.7 GHz)	80 GBd (60 GHz)
N1030A Option EC1	Electrical	20 GHz	127 GHz

[1] Only available with option IRC and compliance not gaureented.

N1040A SIRC filter ranges

Module/Option	Channel	Range[1]	
		Min SIRC Freq.	Max SIRC Freq.
N1040A Option 033	All	10 GHz	38 GHz
N1040A Option 060	All	10 GHz	70 GHz

[1] Only available with option IRC and compliance not gaureented.

N1045B SIRC filter ranges

Module/Option	Channel	Range[1]	
		Min SIRC Freq.	Max SIRC Freq.
N1045B	All	10 GHz	70 GHz

[1] Only available with option IRC and compliance not guaranteed.

N1046A SIRC filter ranges

Module/Option	Channel	Range[1]	
		Min SIRC Freq.	Max SIRC Freq.
N1046A Option 1xF	All	22.5 GHz	130 GHz
N1046A Option 7xF	All	22.5 GHz	80 GHz
N1046A Option 8xF	All	22.5 GHz	90 GHz

[1] Only available with option IRC and compliance not guaranteed.

N1060A SIRC filter ranges

Module/Option	Channel	Range[1]	
		Min SIRC Freq.	Max SIRC Freq.
N1060A Option 050	All	25 GHz	60 GHz
N1060A Option 085	All	10 GHz	75 GHz

[1] Only available with option IRC and compliance not guaranteed.

Module Specifications

NOTE: All specifications describe warranted performance over the temperature range +10°C to + 40°C (unless otherwise noted). The specifications are applicable after the temperature is stabilized, which occurs after 1 hour of continuous operation in final setup configuration and while self calibration is valid. Many performance parameters are enhanced through frequent, simple user calibrations.

NOTE: Specifications describe warranted performance. Characteristics provide useful, nonwarranted information about the functions and performance of the instrument. Characteristics are printed in green italics.

NOTE: Factory Calibration Cycle. For optimum performance, the instrument should have a complete verification of specifications once every 12 months.

NOTE: Nominal Value indicates the expected, but not warranted, value of the parameter.

54754A Module Specifications

54754A general specifications

Item	Description
Channels (user selectable)	
Bandwidth (-3 dB)	dc to 12.4 or 18.0 GHz
The above bandwidths are user selectable. The input sampler is biased differently for increased bandwidth in the 18 GHz bandwidth mode. Channel 1/3 is the TDR input located on the upper left of the module. Channel 2/4 is the electrical input located on the lower left of the module.	
dc Accuracy (single marker when driven from a 0 ohm source)	
12.4 GHz	±0.4% of full scale ±2 mV ±0.6% of reading - channel offset
18 GHz	±0.4% of full scale ±2 mV ±1.2% of reading - channel offset
The above is the DC accuracy when operated within ±2°C (±3.6°F) of the temperature of the last plug-in module calibration. When operated within ±5°C (±9°F) of the temperature of the last module calibration, the final term in the DC accuracy specification is 2.5 times higher.	
dc Difference (two marker accuracy on the same channel)	
12.4 GHz	±0.8% full scale ±1.2% of delta reading
18 GHz	±0.8% full scale ±1.2% of delta reading
The above is the DC difference when operated within ±2°C (±3.6°F) of the temperature of the last plug-in module calibration. When operated within ±5°C (±9°F) of the temperature of the last module calibration, the final term in the DC difference specification is 2.5 times higher.	
Transition Time (10% to 90% calculated from TR = 0.35/BW)	
12.4 GHz	28.2 ps
18 GHz	19.4 ps
RMS Noise Typical	
12.4 GHz	0.25 mV
18 GHz	0.5 mV

Maximum	
12.4 GHz	0.5 mV
18 GHz	1.0 mV
Scale Factor (full height is eight divisions)	
Minimum	1 mV/division
Maximum	100 mV/division
Display Resolution	256 points
dc Offset Range (referenced two divisions from screen bottom)	±500 mV
An effective offset of ± 900 mV can be achieved using the ±500 mV of channel offset and adding ±400 mV of offset using the signal processing math Add function with a constant operand.	
Nominal Impedance	50 ohm
Connectors (channel and trigger)	3.5 mm (m)
Input Reflection/Return Loss	≤ 5% for 30 ps rise time
Number of Channels	2
Dynamic Range/Maximum Specified Input Power	±400 mV relative to channel offset
Maximum Safe Input	±2 V + peak AC (+16 dBm)

54754A TDR system specifications

Normalized information is a characteristic, not a specification. The information is presented here for comparison purposes only. Normalization characteristics are achieved only with the use of the TDR calibration using the firmware routines. Rise time is measured in the Averaged Display mode with best flatness on (default in TDR mode). The rise time of the generator is less than 35 ps, as calculated by:

$$t_r\text{system} = \sqrt{(t_r, \text{generator})^2 + (t_r, \text{scope})^2}$$

NOTE: Flatness is measured in the Averaged Display mode with best flatness on (default in TDR mode).

54754A TDR system specifications

Item	Description
Rise Time	
Combined Oscilloscope and TDR Performance	< 45 ps
Normalized Characteristic	Adjustable: allowable values based on time base setting. (characteristic)Minimum: 17 ps or 0.08 x time/div, whichever is greater. (characteristic)Maximum: 5 x time/div. (characteristic)
Flatness	
Combined Oscilloscope and TDR Performance	< ± 1% after 1 ns from edge. < +5%, –5% to 1 ns from edge.
Normalized Characteristic	< 0.1% (characteristic)
Step Levels	
Combined Oscilloscope and TDR Performance	Low: 0.00V ± 2 mV High: +200 mV ± 2 mV
Normalized Characteristic	Low: 0.00V ± 2 mV (characteristic) High: +200 mV ± 2 mV (characteristic)

86105C Module Specifications

86105C optical channel specifications

Item	Description
Optical Channel Bandwidth (–3 dBo, unfiltered)	8.5 GHz (9 GHz characteristic)
Nominal Wavelength Range	750 to 1650 nm
Calibrated Wavelengths (OE conversion gains)	850 nm/1310 nm/1550 nm (±20 nm)
Option 86105C-100 Series Low-Rate Receiver Filters/Data Rates (Four series-100 options installed in 86105C with 86105C-100)	
86105C-110	OC-3/STM-1, 155 Mb/s
86105C-120	OC-12/STM-4, 622 Mb/s, (Also covers 614 Mb/s)
86105C-130	1x Fibre Channel, 1.063 Gb/s
86105C-140	GPON, 1.244Gb/s and Gigabit Ethernet, 1.250 Gb/s (Also covers 1.229 Gb/s)
86105C-150	2x Fibre Channel, 2.125 Gb/s
86105C-160	OC-48/STM-16, 2.488 Gb/s and 2 Gb Ethernet, 2.500 Gb/s (Also covers 2.458 Gb/s)
86105C-170	OC-48/STM-16 FEC, 2.666 Gb/s
86105C-180	10 Gb Ethernet LX-4, 3.125 Gb/s (Also covers 3.072 Gb/s)
86105C-190	4x Fibre Channel, 4.25 Gb/s
86105C-193	PCIe-2/2x InfiniBand, 5.000 Gb/s
86105C-195	2x XAUI, 6.250 Gb/s (Also covers 6.144 Gb/s)
86105C-197	8x Fibre Channel, 8.500 Gb/s

Option 86105C-200 Receiver Filters/Data Rates (Includes all of the following multiple 10 Gb/s Receiver Filters)	OC-192/STM-64, 9.953 Gb/s 10Gb Ethernet, 10.3125 Gb/s 10x Fibre Channel, 10.51875 Gb/s OC-192/STM-64 FEC, 10.664 Gb/s OC-192/STM-64 FEC, 10.709 Gb/s 10 Gb Ethernet FEC, 11.0957 Gb/s 10x Fibre Channel FEC, 11.317 Gb/s
Option 300 Receiver Filters/Data Rates	
Option 86105C-300 is a combination of four series 86105C-100 low-rate receiver filters and the 86105C-200 10 Gb/s receiver filters.	
Measured frequency response data during recertification falls within Performance Test line limits with allowance for system-to-system measurement uncertainty.	
Sensitivity at 850 nm. (Characteristic - smallest average power for mask test)	
≤ 2.666 Gb/s > 2.666 Gb/s to ≤ 4.25 Gb/s > 4.25 Gb/s to 11.3 Gb/s	–20 dBm –19 dBm –16 dBm
Sensitivity at 1310 nm / 1550 nm. (Characteristic - smallest average power for mask test)	
≤ 2.666 Gb/s > 2.666 Gb/s to ≤ 4.25 Gb/s > 4.25 Gb/s to 11.3 Gb/s	–21 dBm –20 dBm –17 dBm
Transition Time (10% to 90% calculated from TR = 0.48/BW optical)	56 ps
RMS Noise at 850 nm	
≤ 2.666 Gb/s > 2.666 Gb/s to ≤ 4.25 Gb/s > 4.25 Gb/s to 11.3 Gb/s	1.3 µW (Characteristic) 1.5 µW (Characteristic) 2.5 µW (Characteristic)
≤ 2.666 Gb/s > 2.666 Gb/s to ≤ 4.25 Gb/s > 4.25 Gb/s to 11.3 Gb/s	2.0 µW (Maximum) 2.5 µW (Maximum) 4.0 µW (Maximum)
RMS Noise at 1310 nm / 1550 nm	
≤ 2.666 Gb/s > 2.666 Gb/s to ≤ 4.25 Gb/s > 4.25 Gb/s to 11.3 Gb/s	0.8 µW (Characteristic) 1.0 µW (Characteristic) 1.4 µW (Characteristic)
≤ 2.666 Gb/s > 2.666 Gb/s to ≤ 4.25 Gb/s > 4.25 Gb/s to 11.3 Gb/s	1.3 µW (Maximum) 1.5 µW (Maximum) 2.5 µW (Maximum)
Scale Factor (per division)	

Minimum	2 µW
Maximum	100 µW
CW Accuracy (single marker, referenced to average power monitor)	
Single Mode	±25 µW ±3%
Multimode	±25 µW ±10%
CW Offset Range (referenced two divisions from screen bottom)	+0.2 mW to –0.6 mW
Average Power Monitor	–30 dBm to 0 dBm
Average Power Monitor Accuracy	
Single Mode	±5% ± 200 nW ± connector uncertainty
Multimode (characteristic)	±10% ± 200 nW ± connector uncertainty
Due to variations in mode-filling conditions, the measured power in multimode fiber will vary more than the measured power in single-mode fiber. For users needing the most accurate power measurements, use an optical power meter for multimode power measurements.	
User Calibrated Accuracy (Assumes connector is continually attached)	
Single Mode	±3% ± 200 nW ± power meter uncertainty, < 5°C change
Multimode (characteristic)	±10% ± 200 nW ± power meter uncertainty, < 5°C change
Maximum Input Power	
Maximum Non-destruct Average	0.5 mW (–3 dBm)
Maximum Non-destruct Peak	5 mW (+7 dBm)
Input Return Loss (HMS-10 connector fully filled fiber)	
850 nm	> 13 dB
1310 nm / 1550 nm	> 24 dB
Fiber Input	62.5/125 µm
Connector for fiber input is user-selectable.	

86105C electrical channel specifications

Item	Description
Electrical Channel Bandwidth	12.4 and 20 GHz
Transition Time (10% to 90% calculated from TR = 0.35/BW)	
12.4 GHz	28.2 ps
20 GHz	17.5 ps
RMS Noise	
Characteristic	0.25 mV (12.4 GHz) 0.5 mV (20 GHz)
Maximum	0.5 mV (12.4 GHz) 1 mV (20 GHz)
Scale Factor (full height is eight divisions)	
Minimum	1 mV/division
Maximum	100 mV/division
DC Accuracy (single marker)	
12.4 GHz	±0.4% of full scale ± 2 mV ± 1.5% of (reading – channel offset)
20 GHz	±0.4% of full scale ±2 mV ± 3% of (reading – channel offset)
DC Offset Range (referenced to center of display graticule)	±500 mV
Input Dynamic Range (relative to channel offset)	±400 mV
Maximum Input Signal	±2 V DC (+16 dBm)
Nominal Impedance	50 ohm
Reflections (for 30 ps rise time)	5%
Electrical Input	3.5 mm (male)

86105D Module Specifications

86105D optical channel specifications

Item	Description		
Optical Channel Bandwidth (-3 dBo, unfiltered)	20 GHz (dBo), characteristic 34 GHz (dBo), characteristic (Option 281)		
Nominal Wavelength Range	750 to 1650 nm		
Calibrated Wavelengths (OE conversion gains)	850 nm/1310 nm/1550 nm (±20 nm)		
Receiver Filters/Data Rates	8x Fibre Channel (8.500 Gb/s), per T11 FC-PI-4 OC-192/STM-64 (9.953 Gb/s) 10Gb Ethernet (10.3125 Gb/s) 10x Fibre Channel (10.51875 Gb/s) OC-192/STM-64 FEC (10.664 Gb/s) OC-192/STM-64 FEC (10.709 Gb/s) 10 Gb Ethernet FEC (11.0957 Gb/s) 10x Fibre Channel FEC (11.317 Gb/s) 16x Fibre Channel (14.025 Gb/s) 15 Gb (Option 281) 25 Gb Ethernet (25.78125 Gb/s) (Option 281) 25 Gb Ethernet FEC (27.7393 Gb/s) (Option 281) OTU4 FEC / ITU-T G.959.1 (27.952 Gb) (Option 281) 32x Fibre Channel (28.05 Gb/s) (Option 281)		
Optical Sensitivity (smallest average power for mask test) Characteristic	850 nm	1310 nm	1550 nm
8.5 Gb/s to 11.317 Gb/s	–9 dBm	–12 dBm	–12 dBm
14.025 Gb/s	–6 dBm	–9 dBm	–9 dBm
15.0 Gb/s *(Option 281)*	–9 dBm	–8 dBm	–8 dBm
25.78125 Gb/s *(Option 281)*	–6 dBm	–7 dBm	–8 dBm
27.7393 Gb/s to 28.05 Gb/s *(Option 281)*	–5 dBm	–6 dBm	–7 dBm

Transition Time (10% to 90% calculated from TR = 0.48/BW optical inunfiltered BW)	24 ps 15 ps (Option 281)		
RMS Noise (Characteristic)	850 nm	1310 nm	1550 nm
8.5 Gb/s to 11.317 Gb/s	10 µW	5 µW	5 µW
14.025 Gb/s	16 µW	8 µW	8 µW
15.0 Gb/s *(Option 281)*	9 µW	7 µW	8 µW
25.78125 Gb/s *(Option 281)*	17 µW	13 µW	15 µW
27.7393 Gb/s *(Option 281)*	18 µW	15 µW	17 µW
27.952 Gb/s *(Option 281)*	18 µW	15 µW	17 µW
28.05 Gb/s *(Option 281)*	18 µW	15 µW	17 µW
Unfiltered *(Option 281)*	25 µW	18 µW	21 µW
RMS Noise (Maximum)	850 nm	1310 nm	1550 nm
8.5 Gb/s to 11.317 Gb/s	12 µW	7 µW	7 µW
14.025 Gb/s	24 µW	12 µW	12 µW
Scale Factor (per division)	20 µW minimum 500 µW maximum		
CW Accuracy over Temperature Range +20 °C to + 30 °C (single marker, referenced to average power monitor)			
8.5 Gb/s to 11.317 Gb/s	±25 µW ±2%		
14.025 Gb/s	±25 µW ±4%		
Unfiltered	±25 µW ±4%		
15.0 Gb/s *(Option 281) (characteristic)*	±25 µW ±4%		
25.78125 Gb/s *(Option 281) (characteristic)*	±25 µW ±6%		
27.7393 Gb/s to 28.05 Gb/s *(Option 281) (characteristic)*	±25 µW ±6%		
Unfiltered *(Option 281) (characteristic)*	±25 µW ±6%		

CW Offset Range (referenced two divisions from screen bottom)	+1 mW to –3 mW		
Average Power Monitor Operating Range (characteristic)	–30 dBm to +3 dBm		
Average Power Monitor Range Accuracy for Factory Calibrations (characteristic) *Due to variations in mode-filling conditions, the measured power in multimode fiber will vary more than the measured power in single-mode fiber. For users needing the most accurate power measurements, use an optical power meter for multimode power measurements.*			
1550 nm single mode	±5% ± 200 nW ± connector uncertainty		
1550 nm single mode *(Option 281)*	±5% ± 200 nW ± connector uncertainty		
1310 nm single mode	±5% ± 200 nW ± connector uncertainty		
1310 nm single mode *(Option 281)*	±5% ± 200 nW ± connector uncertainty		
850 nm multimode	±10% ± 200 nW ± connector uncertainty		
850 nm multimode *(Option 281)*	±10% ± 200 nW ± connector uncertainty		
Average Power Monitor Range Accuracy for User Calibrations (characteristic). (Assumes connector is continually attached)			
1550 nm single mode	±3% ± 200 nW ± power meter uncertainty		
1550 nm single mode *(Option 281)*	±3% ± 200 nW ± connector uncertainty		
1310 nm single mode	±3% ± 200 nW ± power meter uncertainty		
1310 nm single mode *(Option 281)*	±3% ± 200 nW ± connector uncertainty		
850 nm multimode	±10% ± 200 nW ± power meter uncertainty		
850 nm multimode *(Option 281)*	±10% ± 200 nW ± connector uncertainty		
Maximum Input Power Maximum Non-destruct Average	850 nm	1310 nm	1550 nm
Standard *Option 281*	5mW (7 dBm) 3mW (5 dBm)	5 mW (7 dBm) 6 mW (8 dBm)	5 mW (7 dBm) 6 mW (8 dBm)

Maximum Input Power Maximum Non-destruct Peak (<10 ns duration, maximum 50% duty cycle)	850 nm	1310 nm	1550 nm
Standard *Option 281*	10 mW (10 dBm) 5 mW (7 dBm)	10 mW (10dBm) 10 mW (10dBm)	10 mW (10dBm) 10 mW (10dBm)
Polarization Dependent Loss at 1550 nm	0.2 dB (characteristic)		
Input Return Loss (HMS-10 connector fully filled fiber) (characteristic)	850 nm	1310 nm	1550 nm
Standard *Option 281*	> 14 dB > 13 dB	> 24 dB > 24 dB	> 24 dB > 24 dB
Fiber Input	62.5/125 µm		
Fiber Input Connector	User selectable		

86105D electrical channel specifications

Item	Description
Electrical Channel Bandwidth	25 GHz and 35 GHz (characteristic) 25 GHz and 50 GHz (characteristic) (Option 281)
Transition Time (10% to 90% calculated from TR = 0.35/BW)	
35 GHz	10.0 ps
25 GHz	17.5 ps
25 GHz *(Option 281)*	17.5 ps
50 GHz *(Option 281)*	7 ps
RMS Noise	
35 GHz BW setting	1 mV (0.5 mV characteristic)
25 GHz BW setting	0.5 mV (0.25 mV characteristic)
25 GHz BW setting *(Option 281)*	0.7 mV (0.4 mV characteristic)
50 GHz BW setting *(Option 281)*	1.0 mV (0.6 mV characteristic)
Scale Factor (full height is eight divisions)	
Minimum	1 mV/division
Maximum	100 mV/division
DC Accuracy (single marker)	
35 GHz BW setting	±0.4% of full scale ± 2 mV ±3% of (reading – channel offset)
25 GHz BW setting	±0.4% of full scale ±2 mV ±1.5% of (reading – channel offset)
25 GHz BW setting *(Option 281)*	±0.4% of full scale ±2 mV ±1.5% of (reading – channel offset)
50 GHz BW setting *(Option 281)*	±0.4% of full scale ±2 mV ± 2% of (reading – channel offset)
DC Offset Range (referenced to center of display graticule)	±500 mV
Input Dynamic Range (relative to channel offset)	±400 mV
Maximum Input Signal	± 2V DC (+16 dBm)

Nominal Impedance	50 ohm
Reflections (for 30 ps rise time)	5% (characteristic) 5% (characteristic) (Option 281)
Electrical Input	3.5 mm (male) 2.4 mm (male) (Option 281)

86115D Module Specifications

Specifications

Item	Description		
Optical Channel Bandwidth (-3 dBo, unfiltered)	20 GHz (dBo), characteristic 34 GHz (dBo), characteristic (Option 282)		
Nominal Wavelength Range	750 to 1650 nm		
Calibrated Wavelengths (OE conversion gains)	850 nm/1310 nm/1550 nm (±20 nm)		
Receiver Filters/Data Rates	8x Fibre Channel (8.500 Gb/s), per T11 FC-PI-4 OC-192/STM-64 (9.953 Gb/s) 10Gb Ethernet (10.3125 Gb/s) 10x Fibre Channel (10.51875 Gb/s) OC-192/STM-64 FEC (10.664 Gb/s) OC-192/STM-64 FEC (10.709 Gb/s) 10 Gb Ethernet FEC (11.0957 Gb/s) 10x Fibre Channel FEC (11.317 Gb/s) 16x Fibre Channel (14.025 Gb/s) 15 Gb (Option 282) 25 Gb Ethernet (25.78125 Gb/s) (Option 282) 25 Gb Ethernet FEC (27.7393 Gb/s) (Option 282) OTU4 FEC / ITU-T G.959.1 (27.952 Gb) (Option 282) 32x Fibre Channel (28.05 Gb/s) (Option 282)		
Optical Sensitivity (smallest average power for mask test) Characteristic	850 nm	1310 nm	1550 nm
8.5 Gb/s to 11.317 Gb/s *(Option 002)* 8.5 Gb/s to 11.317 Gb/s *(Option 004)*	–9 dBm –8 dBm	–12 dBm –11 dBm	–12 dBm –11 dBm
14.025 Gb/s *(Option 002)* 14.025 Gb/s *(Option 004)*	–6 dBm –5 dBm	–9 dBm –8 dBm	–9 dBm –8 dBm
15.0 Gb/s *(Option 282)*	–9 dBm	–8 dBm	–8 dBm
25.78125 Gb/s *(Option 282)*	–6 dBm	–7 dBm	–8 dBm

27.7393 Gb/s to 28.05 Gb/s *(Option 282)*	–5 dBm	–6 dBm	–7 dBm
Transition Time (10% to 90% calculated from TR = 0.48/BW optical inunfiltered BW)	24 ps 15 ps (Option 282)		
RMS Noise (Characteristic)	850 nm	1310 nm	1550 nm
8.5 Gb/s to 11.317 Gb/s *(Option 002)* 8.5 Gb/s to 11.317 Gb/s *(Option 004)*	10 µW 12 µW	5 µW 6 µW	5 µW 6 µW
14.025 Gb/s *(Option 002)* 14.025 Gb/s *(Option 004)*	16 µW 20 µW	8 µW 10 µW	8 µW 10 µW
15.0 Gb/s *(Option 282)*	9 µW	7 µW	8 µW
25.78125 Gb/s *(Option 282)*	17 µW	13 µW	15 µW
27.7393 Gb/s *(Option 282)*	18 µW	15 µW	17 µW
27.952 Gb/s *(Option 282)*	18 µW	15 µW	17 µW
28.05 Gb/s *(Option 282)*	18 µW	15 µW	17 µW
Unfiltered *(Option 282)*	25 µW	18 µW	21 µW
RMS Noise (Maximum)	850 nm	1310 nm	1550 nm
8.5 Gb/s to 11.317 Gb/s *(Option 002)* 8.5 Gb/s to 11.317 Gb/s *(Option 004)*	12 µW 14 µW	7 µW 8.5 µW	7 µW 8.5 µW
14.025 Gb/s *(Option 002)* 14.025 Gb/s *(Option 004)*	24 µW 30 µW	12 µW 14 µW	12 µW 14 µW
Scale Factor (per division)	20 µW minimum 500 µW maximum		
CW Accuracy over Temperature Range +20 °C to + 30 °C (single marker, referenced to average power monitor)			
8.5 Gb/s to 11.317 Gb/s	±25 µW ±2%		
14.025 Gb/s	±25 µW ±4%		
Unfiltered	±25 µW ±4%		
15.0 Gb/s *(Option 282) (characteristic)*	*±25 µW ±4%*		

25.78125 Gb/s *(Option 282)* *(characteristic)*	*±25 µW ±6%*
27.7393 Gb/s to 28.05 Gb/s *(Option 282)* *(characteristic)*	*±25 µW ±6%*
Unfiltered *(Option 282)* *(characteristic)*	*±25 µW ±6%*
CW Offset Range (referenced two divisions from screen bottom)	+1 mW to –3 mW
Average Power Monitor Operating Range (characteristic)	–30 dBm to +3 dBm
Average Power Monitor Range Accuracy for Factory Calibrations (characteristic) *Due to variations in mode-filling conditions, the measured power in multimode fiber will vary more than the measured power in single-mode fiber. For users needing the most accurate power measurements, use an optical power meter for multimode power measurements.*	
1550 nm single mode *(Option 002)*	±5% ± 200 nW ± connector uncertainty
1550 nm single mode (*Option 004)*	±5% ± 200 nW ± connector uncertainty ± 0.1% * (ambient temperature – 25°C)
1550 nm single mode *(Option 282)*	±5% ± 200 nW ± power meter uncertainty ± connector uncertainty
1310 nm single mode *(Option 002)*	±5% ± 200 nW ± connector uncertainty
1310 nm single mode *(Option 004)*	±5% ± 200 nW ± connector uncertainty ± 0.1% * (ambient temperature – 25°C)
1310 nm single mode *(Option 282)*	±5% ± 200 nW ± power meter uncertainty ± connector uncertainty
850 nm multimode *(Option 002)*	±10% ± 200 nW ± connector uncertainty
850 nm multimode *(Option 004)*	±10% ± 200 nW ± connector uncertainty ± 0.1% * (ambient temperature – 25°C)
850 nm multimode *(Option 282)*	±10% ± 200 nW ± power meter uncertainty ± connector uncertainty
Average Power Monitor Range Accuracy for User Calibrations (characteristic). (Assumes connector is continually attached)	

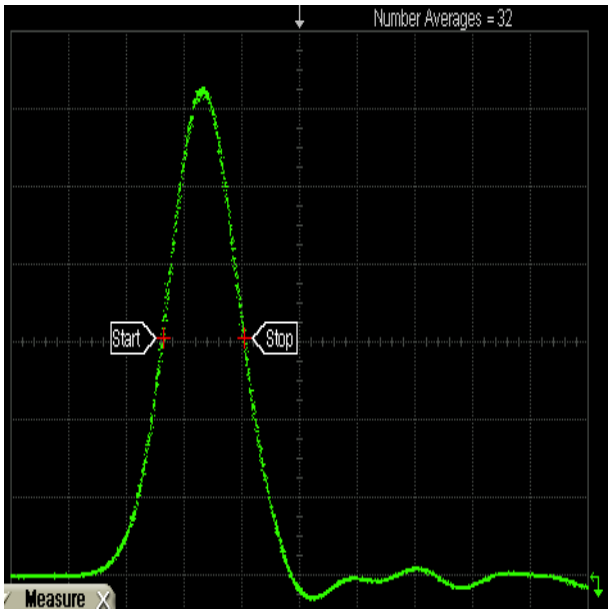
1550 nm single mode *(Option 002)*	±3% ± 200 nW ± power meter uncertainty ± connector uncertainty		
1550 nm single mode *(Option 004)*	±3% ± 200 nW ± power meter uncertainty ± connector uncertainty ± 0.1% * (ambient temperature – 25°C)		
1550 nm single mode *(Option 282)*	±3% ± 200 nW ± connector uncertainty		
1310 nm single mode *(Option 002)*	±3% ± 200 nW ± power meter uncertainty ± connector uncertainty		
1310 nm single mode *(Option 004)*	±3% ± 200 nW ± power meter uncertainty ± connector uncertainty ± connector uncertainty ± 0.1% * (ambient temperature – 25°C)		
1310 nm single mode *(Option 282)*	±3% ± 200 nW ± connector uncertainty		
850 nm multimode *(Option 002)*	±10% ± 200 nW ± power meter uncertainty ± connector uncertainty		
850 nm multimode *(Option 004)*	±10% ± 200 nW ± power meter uncertainty ± connector uncertainty ± 0.1% * (ambient temperature – 25°C)		
850 nm multimode *(Option 282)*	±10% ± 200 nW ± connector uncertainty		
Maximum Input Power Maximum Non-destruct Average	850 nm	1310 nm	1550 nm
Standard *Option 282*	5mW (7 dBm) 3mW (5 dBm)	5 mW (7dBm) 6 mW (8dBm)	5 mW (7dBm) 6 mW (8dBm)
Maximum Input Power Maximum Non-destruct Peak (<10 ns duration, maximum 50% duty cycle)	850 nm	1310 nm	1550 nm
Standard *Option 282*	10 mW (10 dBm) 5 mW (7 dBm)	10 mW (10dBm) 10 mW (10dBm)	10 mW (10dBm) 10 mW (10dBm)
Polarization Dependent Loss at 1550 nm	0.2 dB (characteristic)		
Input Return Loss (HMS-10 connector fully filled fiber) (characteristic)	850 nm	1310 nm	1550 nm
Standard *Option 282*	> 14 dB > 13 dB	> 24 dB > 24 dB	> 24 dB > 24 dB
Fiber Input	62.5/125 µm		
Fiber Input Connector	User selectable		

86116C Module Specifications

86116C optical channel specifications (Option 025)

Item	Description
Wavelength Range	1300 nm to 1620 nm
Fiber Input	9/125 µm, straight. Connector for fiber input is user-changeable.
Reference Receiver Data Rates	17.0, 25.8, 27.7 Gb/s
Calibrated Wavelength (DC Responsivity)	1310 nm and 1550 nm
Optical Bandwidth (Unfiltered) –3 dB optical (–6 dB electrical). Calculated from optical impulse pulse width measurements on a 1550 nm optical impulse: BW = 0.48/FWHM.	> 40 GHz 45 GHz (characteristic)
Sensitivity at 27.7 Gb/s	
1310 nm 1550 nm	–7 dBm (characteristic) –8 dBm (characteristic)
Sensitivity at 25.8 Gb/s	
1310 nm 1550 nm	–8 dBm (characteristic) –9 dBm (characteristic)
Sensitivity at 17 Gb/s	
1310 nm 1550 nm	–9 dBm (characteristic) –10 dBm (characteristic)
Peak Amplitude	
Non-destructive	10 mW average
Displayed peak	4 mW
Impulse Rise Time at 40 GHz BW (10% to 90% measured from impulse response)	9 ps (characteristic)

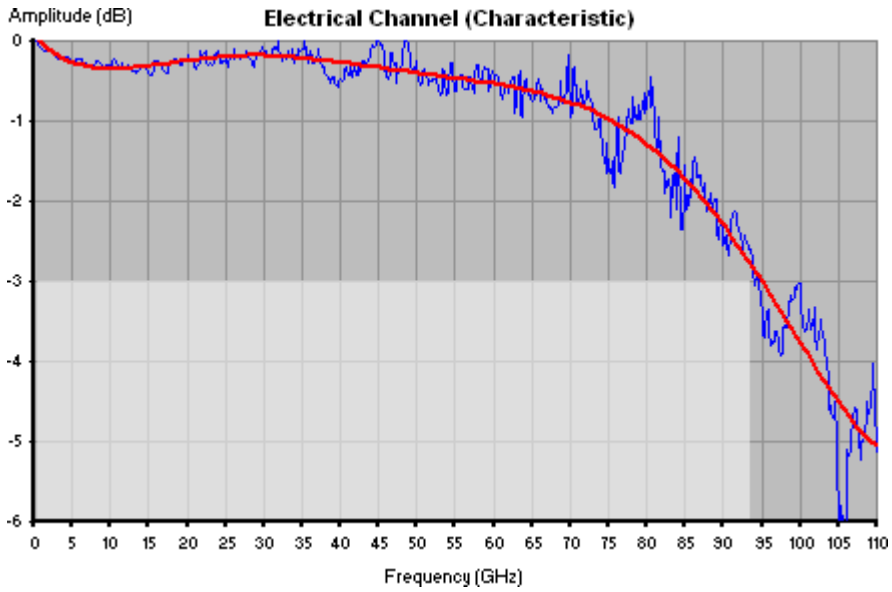
Optical FWHM at 40 GHz BW. Measured with 1550 nm optical impulse with a pulse of 700 fs FWHM, 5 MHz repetition rate, and 4 mW peak power. System jitter less than 800 fs RMS. Description: 12 ps (characteristic)



Polarization Dependent Loss (PDL)	< 0.8 dB (characteristic)
Optical Noise (1310 nm) The noise specification is over the full temperature range of +10° C to +40° C.	
40 GHz Setting	120 µW 60 µW, characteristic
27.7 Gb/s Setting	30 µW 20 µW, characteristic
25.8 Gb/s Setting	20 µW 17 µW, characteristic
17.0 Gb/s Setting	18 µW 13 µW, characteristic
Optical Noise (1550 nm) The noise specification is over the full temperature range of +10° C to +40° C.	
40 GHz Setting	80 µW 40 µW, characteristic
27.7 Gb/s Setting	21 µW 14 µW, characteristic
25.8 Gb/s Setting	18 µW 12 µW, characteristic
17.0 Gb/s Setting	15 µW 10 µW, characteristic

Scale Factor (full height is eight divisions)	
Maximum Minimum	500 µW/division 20 µW/division
CW Optical Power Accuracy (single marker, referenced to average power monitor)	±150 µW ±4% of (reading – channel offset)
CW Optical Power Offset (referenced two divisions from screen bottom)	–3 mW to + 1 mW
Average Optical Power Monitor (1300 nm — 1330 nm, 1480 nm — 1620 nm)	–23 dBm to +6 dBm (5 µW to 4 mW)
Average Optical Power Factory Calibrated Accuracy Conditions: CW optical power only (no modulation).	±5% ± 100 nW ± connector uncertainty, 20°C to 30°C
Average Optical Power User Calibrated Accuracy Conditions: CW optical power only (no modulation).	±5% ± 100 nW ± connector uncertainty, 20° C to 30° C ±2% ± 100 nW power meter uncertainty, < 5° C change
Maximum Input Average Optical Power	
Maximum Displayed Peak	4 mW (+6 dBm)
Maximum Linear Peak	3 mW (+4.8 dBm) (characteristic)
Maximum Non-destruct Peak	40 mW (+16 dBm), or 0.25 pJ per pulse, whichever is less (characteristic)
Maximum Non-destruct average	10 mW (+10 dBm) (characteristic)
Maximum non-destruct power is related to the fill factor (duty cycle) of the RZ waveform. The factory specification is defined by using a 20% filled 40 Gb/s pulse train (in other words, 5 ps FWHM and 25 ps period). This concept can also be specified as maximum non-destruct pulse energy. The factory specification is specified with 5 ps FWHM optical pulses and maximum non-destruct power providing that the individual pulse shape is square.	
Input Return Loss (HMS-10 connector fully filled fiber) Proper connector care is required to maintain this specification.	20 dB

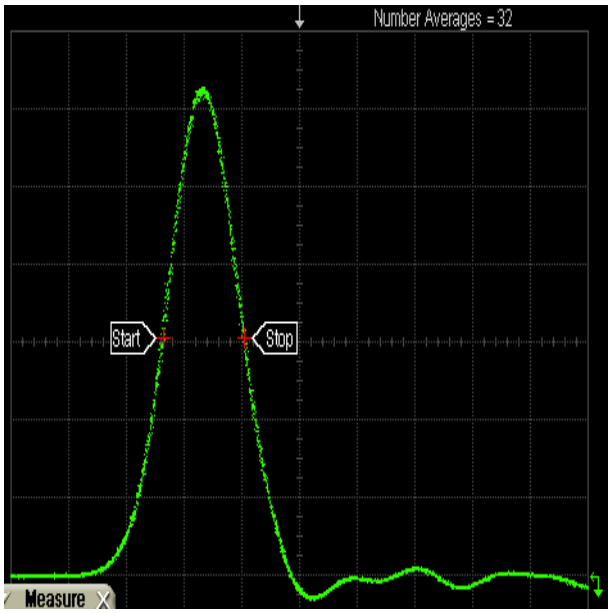
86116C electrical channel specifications (Option 025)

Item	Description
Channel Bandwidth	80 GHz (93 GHz characteristic, see following figure), 55 GHz, and 30 GHz
This graph shows the electrical channel frequency response (characteristic) at the 80 GHz setting. The blue curve is the unfiltered data, the red curve is a curve fit. 	
Risetime 10% to 90%. Calculated from tr = 0.35/BW.	
80 GHz Setting	3.7 ps (characteristic)
55 GHz Setting	6.4 ps (characteristic)
30 GHz Setting	11.7 ps (characteristic)
Noise Measured one standard deviation from mean.	
80 GHz Setting (best pulse fidelity)	2.2 mV, maximum 1.1 mV, characteristic
55 GHz Setting (better sensitivity)	1.2 mV, maximum 0.6 mV, characteristic
30 GHz Setting (best sensitivity)	0.8 mV, maximum 0.5 mV, characteristic

Scale Factor (full height is eight divisions)	
Electrical Maximum	100 mV/division
Electrical Minimum	2 mV/division
dc Accuracy (single marker)	± 0.4% of full scale ± 3 mV ± 2% of (reading – channel offset) ± 2% of offset (all bandwidths)
Offset Range (referenced to center of display graticule)	±500 mV
Input Dynamic Range (relative to channel offset)	±400 mV
Maximum Input Signal	± 2 Vdc (+16 dBm)
Nominal Impedance	50 ohm
Reflections (for 20 ps rise time)	10% (DC to 70 GHz) 20% (70 to 100 GHz)
Input Connector	1.85 mm, male

86116C optical channel specifications (Option 041)

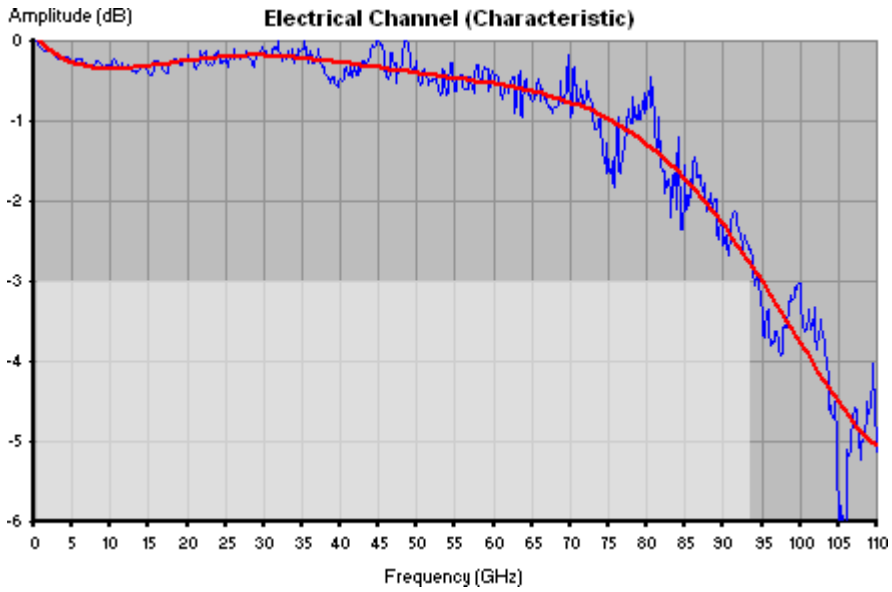
Item	Description
Wavelength Range	1300 nm to 1620 nm
Fiber Input	9/125 µm, straight. Connector for fiber input is user-changeable.
Reference Receiver Data Rates	
Option 041	39.813 Gb/s, 41.25 Gb/s, 43.018 Gb/s
Calibrated Wavelength (DC Responsivity)	1310 nm and 1550 nm
Optical Bandwidth (Unfiltered) –3 dB optical (–6 dB electrical). Calculated from optical impulse pulse width measurements on a 1550 nm optical impulse: BW = 0.48/FWHM.	>65 GHz 70 GHz (characteristic)
Risetime 10% to 90%. Calculated from tr = 0.35/BW.	
65 GHz Setting 60 GHz Setting 55 GHz Setting	5.0 ps (characteristic) 5.8 ps (characteristic) 6.4 ps (characteristic)
Sensitivity (at 39.8 Gb/s and 43.0 Gb/s)	

1310 nm 1550 nm	–3 dBm (characteristic) –5 dBm (characteristic)
Impulse Rise Time at 65 GHz BW (10% to 90% measured from impulse response)	5.4 ps (characteristic)
Optical FWHM at 65 GHz BW. Measured with 1550 nm optical impulse with a pulse of 700 fs FWHM, 5 MHz repetition rate, and 10 mW peak power. System jitter less than 800 fs RMS. Description: 7.4 ps (characteristic)	
Impulse Distortion Impulse distortion (%) = [(distortion peak-to-peak)/impulse height] x 100%.	< 10% (characteristic)
Average Input Power for Linear Operation using 40 Gb/s RZ Signals Tested with 40 Gb/s RZ signals with pulses of 6 ps (FWHM).	< 5 mW (characteristic)
Polarization Dependent Loss (PDL)	< 0.8 dB (characteristic)
Optical Noise (1310 nm) The noise specification is over the full temperature range of +10° C to +40° C.	
65 GHz Setting	300 µW 187 µW, characteristic
60 GHz Setting	225 µW 105 µW, characteristic
55 GHz Setting	127 µW 75 µW, characteristic
39.8 Gb/s and 43.0 Gb/s reference receivers	102 µW 54 µW, characteristic

Optical Noise (1550 nm) The noise specification is over the full temperature range of +10° C to +40° C.	
65 GHz Setting	200 µW 125 µW, characteristic
60 GHz Setting	150 µW 70 µW, characteristic
55 GHz Setting	85 µW 50 µW, characteristic
39.8 Gb/s and 43.0 Gb/s reference receivers	68 mµW 36 µW, characteristic
Scale Factor (full height is eight divisions)	
Maximum	5 mW/division
Minimum	200 µW/division
CW Optical Power Accuracy (single marker, referenced to average power monitor)	±150 µW ±4% of (reading – channel offset)
CW Optical Power Offset (referenced two divisions from screen bottom)	–12 mW to +8 mW
Average Optical Power Monitor (1300 — 1330 nm, 1480 — 1620 nm)	–23 dBm to +9 dBm (5 µW to 8 mW)
Average Optical Power Factory Calibrated Accuracy Conditions: CW optical power only (no modulation).	±5% ±100 nW ±connector uncertainty, 20°C to 30°C
Average Optical Power User Calibrated Accuracy Conditions: CW optical power only (no modulation).	±5% ± 100 nW ± connector uncertainty, 20° C to 30° C ±2% ± 100 nW power meter uncertainty, < 5° C change
Maximum Input Average Optical Power	
Maximum Displayed Peak	40 mW (+16 dBm)
Maximum Linear Peak	30 mW (+14.8 dBm), or 0.15 pJ per pulse, whichever is less (characteristic)
Maximum Non-destruct Peak	40 mW (+16 dBm), or 0.25 pJ per pulse, whichever is less (characteristic)
Maximum Non-destruct average	10 mW (+10 dBm) (characteristic)

Maximum non-destruct power is related to the fill factor (duty cycle) of the RZ waveform. The factory specification is defined by using a 20% filled 40 Gb/s pulse train (in other words, 5 ps FWHM and 25 ps period). This concept can also be specified as maximum non-destruct pulse energy. The factory specification is specified with 5 ps FWHM optical pulses and maximum non-destruct power providing that the individual pulse shape is square.	
Input Return Loss (HMS-10 connector fully filled fiber) Proper connector care is required to maintain this specification.	20 dB

86116C electrical channel specifications (Option 041)

Item	Description
Channel Bandwidth	80 GHz (93 GHz characteristic, see following figure), 55 GHz, and 30 GHz
This graph shows the electrical channel frequency response (characteristic) at the 80 GHz setting. The blue curve is the unfiltered data, the red curve is a curve fit. 	
Risetime. 10% to 90%. Calculated from tr = 0.35/BW.	
80 GHz Setting	3.7 ps (characteristic)
55 GHz Setting	6.4 ps (characteristic)
30 GHz Setting	11.7 ps (characteristic)
Noise Measured one standard deviation from mean.	
80 GHz Setting (best pulse fidelity)	2.2 mV, maximum 1.1 mV, characteristic
55 GHz Setting (better sensitivity)	1.1 mV, maximum 0.6 mV, characteristic
30 GHz Setting (best sensitivity)	0.8 mV, maximum 0.5 mV, characteristic

Scale Factor (full height is eight divisions)	
Electrical Maximum	100 mV/division
Electrical Minimum	2 mV/division
dc Accuracy (single marker)	± 0.4% of full scale ± 3 mV ± 2% of (reading – channel offset) ± 2% of offset (all bandwidths)
Offset Range (referenced to center of display graticule)	±500 mV
Input Dynamic Range (relative to channel offset)	±400 mV
Maximum Input Signal	± 2Vdc (+16 dBm)
Nominal Impedance	50 ohm
Reflections (for 20 ps rise time)	10% (DC to 70GHz) 20% (70 to 100GHz)
Input Connector	1.85 mm, male

N1030A/B Module Specifications

N1030A/B optical channel specifications

Item	Description	
Optical Channel Count	1 (N1030A) 2 (N1030B)	
Optical Channel Bandwidth, −3 dBo	65 GHz (characteristic) [1] 60 GHz [2]	
Nominal Wavelength Range	1250 nm to 1600 nm	
Factory calibrated wavelengths [3]	1310 nm (±20 nm) 1550 nm (±20 nm)	
User calibration wavelength range	1250 nm to 1600 nm	
Reference receiver filters [4]		
25 Gb/s Ethernet (25.78125 Gb/s) 400GBASE-SR16 (26.5625 Gb/s) Ethernet OTU4 FEC/ITU-T G.959.1 (27.952493 Gb/s) 32G Fibre Channel (28.05 Gb/s) 53.125 GBaud PAM4 TDECQ (26.6 GHz) 53.125 GBaud NRZ (39.8 GHz)		
RMS Noise (Characteristic)	1310 nm	1550 nm
25 Gb/s Ethernet (25.78125 Gb/s)	16 µW	18 µW
400GBASE-SR16 (26.5625 Gb/s)	16 µW	18 µW
Ethernet OTU4 FEC/ITU-T G.959.1 (27.952493 Gb/s)	16 µW	18 µW
32G Fibre Channel (28.05 Gb/s)	16 µW	18 µW
53.125 GBaud PAM4 TDECQ (26.6 GHz)	18 µW	22 µW
53.125 GBaud NRZ (39.8 GHz)	30 µW	35 µW
Unfiltered (60 GHz)	35 µW	45 µW

Unfiltered (65 GHz)	80 µW	95 µW
RMS Noise (Maximum)	1310 nm	1550 nm
25 Gb/s Ethernet (25.78125 Gb/s)	20 µW	25 µW
400GBASE-SR16 (26.5625 Gb/s)	20 µW	25 µW
Ethernet OTU4 FEC/ITU-T G.959.1 (27.952493 Gb/s)	20 µW	25 µW
32G Fibre Channel (28.05 Gb/s)	20 µW	25 µW
53.125 GBaud PAM4 TDECQ (26.6 GHz)	30 µW	35 µW
53.125 GBaud NRZ (39.8 GHz)	40 µW	55 µW
Unfiltered (60 GHz)	50 µW	65 µW
Unfiltered (65 GHz)	105 µW	110 µW
Optical Sensitivity (Characteristic) [5]	1310 nm	1550 nm
25 Gb/s Ethernet (25.78125 Gb/s)	–6.5 dBm	–6.0 dBm
400GBASE-SR16 (26.5625 Gb/s)	–6.5 dBm	–6.0 dBm
Ethernet OTU4 FEC/ITU-T G.959.1 (27.952493 Gb/s)	–6.5 dBm	–6.0 dBm
32G Fibre Channel (28.05 Gb/s)	–6.5 dBm	–6.0 dBm
Scale Factor Specifications (per division, 8 divisions)		
Minimum	5 µW	
Maximum	500 µW	
CW Offset Range [6]	+1.0 mW to −3 mW	
CW Accuracy (single mode)[7]	±15 µW ±1.5% of reading ± connector uncertainty (Characteristic) ±30 µW ±3% of reading ± connector uncertainty	
Maximum Measureable Input Power	4 mW at 500 µW/division scale factor	
Average Power Monitor Range	−30 dBm to +6 dBm (1310 nm) −30 dBm to +6 dBm (1550 nm)	
Average Power Monitor Accuracy [8]		
For 1 µW ≤ P_{input} ≤ 2 mW	200 nW ± 5% of reading ± connector uncertainty	

For 2 mW ≤ P_{input} ≤ 4 mW	200 nW ± 10% of reading − 100µW ± connector uncertainty
Maximum Non-destruct Peak Power	5 mW (+7 dBm)
Fiber Input	9/125 µm
Fiber Input Connector	FC
Channel ADC	16 bits

[1] With the unfiltered setting selected, −3 dBo is calculated from the −6 dBe point.

[2] Tuned to –3 dBo (± measurement uncertainty) at stated bandwidth(s).

[3] For the average power monitor and the channel vertical path.

[4] The frequency response is verified using an optical impulse (< 1 ps FWHM).

[5] Generally represents the power level where an ideal eye diagram will approach 0% mask margin due to the noise of the oscilloscope. Provides a *non-specified* figure of merit to compare sensitivities of various optical channels. These values are calculated from the characteristic noisevalues.

[6] Referenced two divisions from screen bottom.

[7] Single marker, referenced to power sensor.

[8] Average power monitor accuracy is tied to the calibration accuracy of the power sensor.

N1030A (Option EC1) electrical channel specifications

Item	Description
Electrical Channel Count	1
Electrical Input Connectors	1 mm (m) bulkhead
Bandwidth, −3 dB (user selectable)	33, 40, 50, 70, 85, and 95 GHz [1]
Transition Time (10% to 90% calculated from TR = 0.35/BW)	
33 GHz BW	10.6 ps (Calculated)
40 GHz BW	8.8 ps (Calculated)
50 GHz BW	7.0 ps (Calculated)
70 GHz BW	5 ps (Calculated)
85 GHz BW	4.2 ps (Calculated)
95 GHz BW	3.7 ps (Calculated)
RMS Noise (Characteristic)	
33 GHz BW	350 µV (Characteristic)
40 GHz BW	350 µV (Characteristic)
50 GHz BW	450 µV (Characteristic)
70 GHz BW	650 µV (Characteristic)
85 GHz BW	950 µV (Characteristic)
95 GHz BW	1150 µV (Characteristic)
RMS Noise (Maximum)	
33 GHz BW	450 µV
40 GHz BW	500 µV
50 GHz BW	600 µV
70 GHz BW	800 µV
85 GHz BW	1200 µV
95 GHz BW	1400 µV

Scale Factor (per division)	
Minimum	1 mV/division
Maximum	100 mV/division
DC Accuracy (V_{AVG} Measurement) (at 33, 40, 50, 70, 85, 95 GHz BWs) [2]	
Specification	±2 mV ±4% (reading − offset)
Characteristic	±2 mV
DC Offset Range (referenced to center of screen)	±500 mV
Input Dynamic Range (relative to channel offset)	±400 mV
Maximum Input Signal	± 2V (+16 dBm)
Maximum Sample Rate	
When used in an 86100D mainframe	40 kSa/s (Characteristic)
When used in an N1000A mainframe	250 kSa/s (Characteristic)
Nominal Input Impedance	50Ω

[1] Tuned to be −3 dB (± measurement uncertainty) at stated bandwidth(s).

[2] Specified at calibration temperature ±0.5 °C. Perform a new module calibration if hardware skew has been applied.

N1040A Module Specifications

N1040A specifications

Item	Description	
Electrical Channel Count	2	
Electrical Input Connectors	Option 033	Option 060
	2.92 mm	1.85 mm
Bandwidth, 3 dB (user selectable) [1]	Option 033	Option 060
	20 GHz 33 GHz	20 GHz 33 GHz 40 GHz 60 GHz
Transition Time (10% to 90% calculated from TR = 0.35/BW)	Option 033	Option 060
20 GHz BW	17.5 ps (Calculated)	17.5 ps (Calculated)
33 GHz BW	10.6 ps (Calculated)	10.6 ps (Calculated)
40 GHz BW	—	8.8 ps (Calculated)
60 GHz BW	—	5.8 ps (Calculated)
Channel-to-Channel Skew Range	±100 ps	
RMS Noise	Option 033	Option 060
20 GHz BW	275 µV (Characteristic)	275 µV (Characteristic)
33 GHz BW	350 µV (Characteristic)	350 µV (Characteristic)
40 GHz BW	—	450 µV (Characteristic)
60 GHz BW	—	550 µV (Characteristic)
RMS Noise (Maximum)	500 µV	800 µV
Scale Factor (per division)		

Minimum	1 mV/division
Maximum	100 mV/division
DC Accuracy (V_{AVG} Measurement) (at 20, 33, 40, 60 GHz BWs)[2]	
Specification	±2 mV ± 4% of (reading – channel offset)
Characteristic	±1.15 mV
DC Offset Range (referenced to center of screen)	±500 mV
Input Dynamic Range (relative to channel offset)	±400 mV
Maximum Input Signal	± 2V (+16 dBm)
Maximum Sample Rate	
When used in an 86100D mainframe	40 kSa/s (Characteristic)
When used in an N1000A mainframe	250 kSa/s (Characteristic)
Nominal Input Impedance	50Ω
Reflections (for 30 ps rise time)	20% (Characteristic)

[1] Tuned to be –3 dB (± measurement uncertainty) at stated bandwidths.

[2] Specified at calibration temperature ±0.5 °C. Perform a new module calibration if hardware skew has been applied.

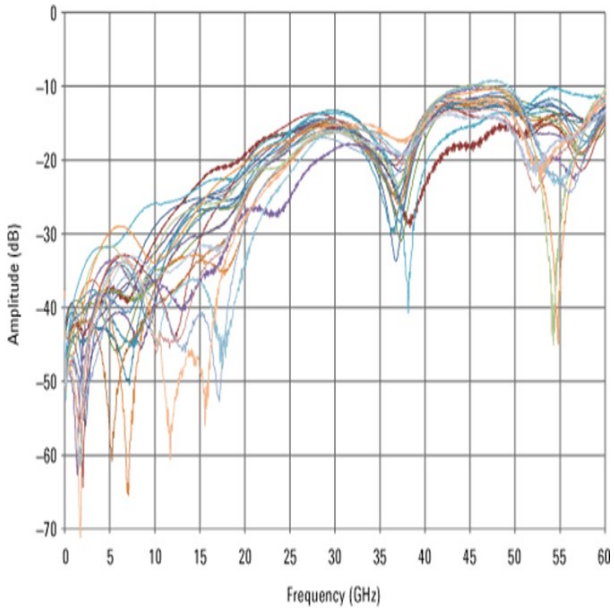
N1045B Module Specifications

N1045B specifications

Item	Description
Electrical Input Channels (per option)	
02F	2 Channel Remote Head with 1.85 mm (f) connectors.
02M	2 Channel Remote Head with 1.85 mm (m) connectors.
04F	4 Channel Remote Head with 1.85 mm (f) connectors.
04M	4 Channel Remote Head with 1.85 mm (m) connectors.
Remote Head Cable Length	The nominal length of the remote head cables is 1270 mm as measured from the module's front panel to the remote head's casing.
Bandwidth, 3 dB (user selectable)	*20 GHz (Characteristic)* *35 GHz (Characteristic)* *45 GHz (Characteristic)* 60 GHz
Transition Time (10% to 90% calculated from TR = 0.35/BW)	
20 GHz BW	*17.5 ps (Calculated)*
35 GHz BW	10 ps (Calculated)
45 GHz BW	7.8 ps (Calculated)
60 GHz BW	5.8 ps (Calculated)
Channel-to-Channel Skew Range	±100 ps
RMS Noise	
20 GHz BW	310 µV (Characteristic)
35 GHz BW	450 µV (Characteristic)

45 GHz BW	530 µV (Characteristic)
60 GHz BW	875 µV (Characteristic)
RMS Noise *(Maximum)*	975 µV (60 GHz BW setting)
Scale Factor (per division)	
Minimum	1 mV/division
Maximum	100 mV/division
DC Accuracy (V_{AVG} Measurement). Specified at calibration temperature ±0.5 °C. (Perform a new module calibration if hardware skew has been applied.)	
20, 35, 45, 60 GHz	±1.15 mV (Characteristic)
DC Accuracy (V_{AVG} Measurement). Specified at calibration temperature ±5 °C.	
20, 35, 45, 60 GHz	±2 mV ± 4% of (reading – channel offset)
DC Offset Range (referenced to center of screen)	±500 mV
Input Dynamic Range (relative to channel offset)	±400 mV
Maximum Input Signal	± 2V (+16 dBm)
Maximum Sample Rate	250 kSa/s (when used in N1000A Mainframe, Characteristic) 40 kSa/s (when used in 86100D Mainframe, Characteristic)
Nominal Input Impedance	*50Ω (Characteristic)*
Reflections (for 30 ps rise time)	*20% (Characteristic)*

Input Impedance (Graph of S11) , *Characteristic*



N1046A Module Specifications

N1046A maximum BW per option specifications

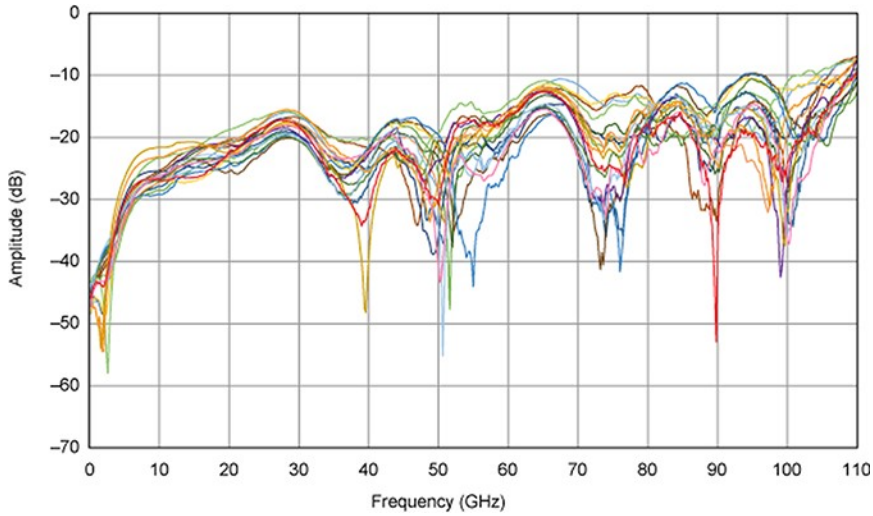
Option	*Maximum* BW								
	1 Channel			2 Channel			4 Channel		
	75 GHz	85 GHz	100 GHz	75 GHz	85 GHz	100 GHz	75 GHz	85 GHz	100 GHz
71F	♦								
81F		♦							
11F			♦						
72F				♦					
82F					♦				
12F						♦			
74F							♦		
84F								♦	
14F									♦

N1046A specifications

Item	Description		
Bandwidth[a], 3 dB (user selectable)	Options		
	71F, 72F, and 74F	81F, 82F, and 84F	11F, 12F, and 14F
45 GHz	♦	♦	♦
60 GHz	♦	♦	♦
75 GHz	♦	♦	♦
85 GHz		♦	♦
100 GHz			♦
122 GHz (Characteristic)			♦
Transition Time (10% to 90% calculated from t_r = 0.35/BW)	Options		
	71F, 72F, and 74F	81F, 82F, and 84F	11F, 12F, and 14F
45 GHz	7.8 ps	7.8 ps	7.8 ps
60 GHz	5.9 ps	5.9 ps	5.9 ps
75 GHz	4.7 ps	4.7 ps	4.7 ps
85 GHz	—	4.2 ps	4.2 ps
100 GHz	—	—	3.5 ps
122 GHz (Characteristic)	—	—	< 3.2 ps
Channel-to-Channel Skew Range	±100 ps		
RMS Noise	Options		
	71F, 72F, and 74F	81F, 82F, and 84F	11F, 12F, and 14F
45 GHz	600 µV 440 µV (Characteristic)	600 µV 440 µV (Characteristic)	600 µV 440 µV (Characteristic)
60 GHz	750 µV 580 µV (Characteristic)	750 µV 580 µV (Characteristic)	750 µV 580 µV (Characteristic)

75 GHz	1 mV 780 µV (Characteristic)	1 mV 780 µV (Characteristic)	1 mV 780 µV (Characteristic)
85 GHz	—	1200 µV 900 µV (Characteristic)	1200 µV 900 µV (Characteristic)
100 GHz	—	—	1400 µV 1050 µV (Characteristic)
122 GHz (Characteristic)	—	—	2000 µV (Characteristic)
Scale Factor (per division)			
Minimum	1 mV/division		
Maximum	100 mV/division		
DC Accuracy (V_{AVG} Measurement)			
Specified at calibration temperature ±0.5 °C. (Perform a new module calibration if hardware skew has been applied.)	*±2 mV (Characteristic)*		
Specified at calibration temperature ±5 °C.	±2 mV ± 4% of (reading – channel offset)		
DC Offset Range (referenced to center of screen)	±500 mV		
Input Dynamic Range (relative to channel offset)	±400 mV		
Maximum Input Signal	± 2V (+16 dBm)		
Maximum Sample Rate	When used in an 86100D mainframe: 40 kSa/s (Characteristic). When used in an N1000A mainframe: 250 kSa/s (Characteristic)		
Nominal Input Impedance	*50Ω (Characteristic)*		
Remote Head Cable Length	The nominal length of the remote head cables is 1270 mm as measured from the module's front panel to the remote head's casing.		
Input Impedance			

Graph of S11 *(Characteristic)*



a. Tuned to be –3 dB (±measurement uncertainty) at stated bandwidth(s), except for 122 GHz which is tuned for highest bandwidth while keeping channel noise ≤ 2.5 mV RMS.

N1055A Module Specifications

N1055A general specifications

Item	Module Options (Connectors: F = female, M = male)			
	N1055A-32F N1055A-32M	N1055A-34F N1055A-34M	N1055A-52F N1055A-52M	N1055A-54F N1055A-54M
Number of Channels	2 [a]	4	2 [a]	4
Remote Head Cable Length	The nominal length of the remote head cables is 1270 mm as measured from the module's front panel to the remote head's casing.			
Electrical Input [b]	2.92 mm (female or male)		1.85 mm (female or male)	
Electrical Channel Bandwidth	35 GHz [c, d]		35 GHz or 50 GHz [d]	
Receiver Transition Time (10% to 90% calculated from T_R = 0.35/BW)	*10 ps, characteristic*		*10 ps (35 GHz BW setting), characteristic* *7 ps (50 GHz BW setting), characteristic*	
Channel-to-Channel Skew Range	±150 ps			
Vertical Resolution	16 bit A/D converter			
RMS Noise	*600 µV, characteristic* 730 µV, maximum		*600 µV (35 GHz BW setting), characteristic* *750 µV (50 GHz BW setting), characteristic* 950 µV (50 GHz BW setting), maximum	
Scale Factor (Per Division)				
Minimum	1 mV / division			
Maximum	100 mV / division			

DC Accuracy (V_{AVG} Measurement)	*±800 uV, characteristic* Specified at calibration temperature ±0.5° C. (Perform a new module calibration if hardware skew has been applied.)
	±2 mV ±4% of (reading–channel offset) Specified at calibration temperature ±10° C
DC Offset Range (referenced from center of screen)	±500 mV
Input Dynamic Range (relative to channel offset)	±400 mV
Maximum Input Signal	+2V / –1V
Nominal Impedance	50 ohm
Maximum Sample Rate, module timebase [e]	
Option-FS1	*250 kSa/s, characteristic*
standard	*80 kSa/s, characteristic*
TDR Step Repetition Rate [e]	
Mainframe Timebase	*1 kHz to 250 kHz, characteristic*
Module timebase (standard)	*1 kHz to 80 kHz, characteristic*
Module timebase (Option FS1)	*1 kHz to 250 kHz, characteristic*

a. Upgradable from 2 channel to 4 channel after purchase (return to Keysight).
b. Connector style is the same on all channels and is selected at time of order.
c. Upgradable from 35 GHz to 50 GHz after purchase (return to Keysight).
d. Tuned to be –3 dB (±measurement uncertainty) at stated bandwidth(s) using NIST traceable swept-sine test system.
e. FlexDCA software auto-selects the mainframe or module timebase dependent on the DUT setup. In cases where the mainframe timebase is used, the maximum sample rate will be:
86100D Mainframe: 40 kSa/s for standard modules and modules with option-FS1, *(characteristic)*.
N1000A Mainframe: 80 kSa/s for standard modules and 250 kSa/s for modules with option-FS1, *(characteristic)*.

TDR system specifications

Item	Module Options (Connectors: F = female, M = male)	
	N1055A-32F N1055A-32M N1055A-34F N1055A-34M	N1055A-52F N1055A-52M N1055A-54F N1055A-54M
Incident [a, b] TDR Step Transition Time (10 % to 90 %)		
Without TDR Calibration	< 18 ps	< 7 ps
With TDR Calibration	Adjustable from 15 ps, characteristic	Adjustable from 6 ps, characteristic
Reflected [b] TDR Step Transition Time (10% to 90%)		
Without TDR Calibration	< 20 ps	< 11 ps
With TDR Calibration	< 18 ps	9.5 ps, characteristic
TDR Step Amplitude (Combined Oscilloscope and TDR Performance)	100 mV Setting: 0 mV to ±100 mV 200 mV Setting: 0 mV to ±200 mV	100 mV Setting: 0 mV to ±100 mV 200 mV Setting: 0 mV to ±200 mV

a. Incident TDR edge speed is defined as the transition time at the output of the remote head. It is calculated by de-convolving the receiver transition time from the measured transition time when the remote head is terminated with a short.
b. Measured on a negative TDR step, terminated in a short.

Step flatness (graphs of combined oscilloscope and TDR performance)

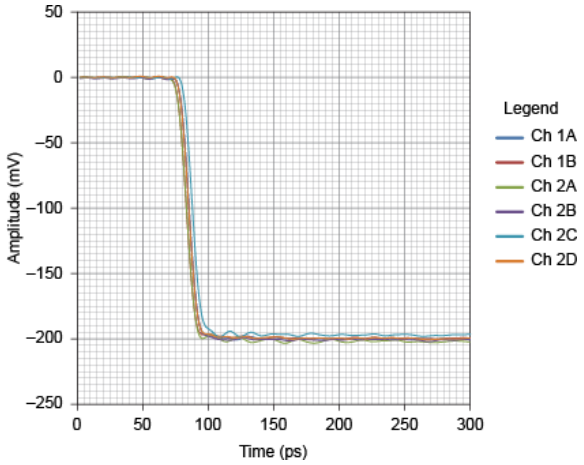


Figure 1. *Options 52F, 52M, 54F, and 54M with TDR Calibration* (Characteristic)

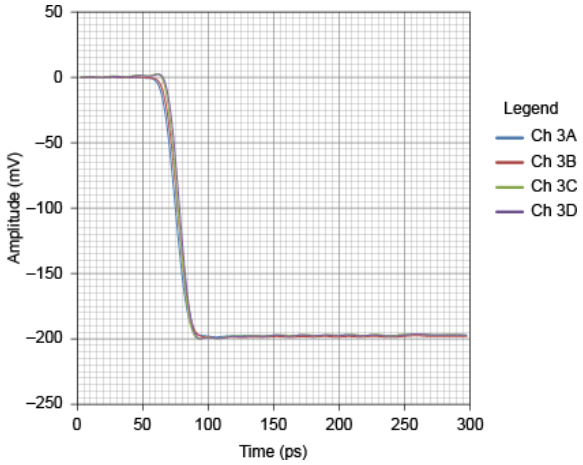


Figure 2. *Options 32F, 32M, 34F, and 34M with TDR Calibration* (Characteristic)

In the following two graphs, the blue trace shows Channel A, the red trace shows Channel B, The green trace shows Channel C, and the yellow trace shows Channel D.

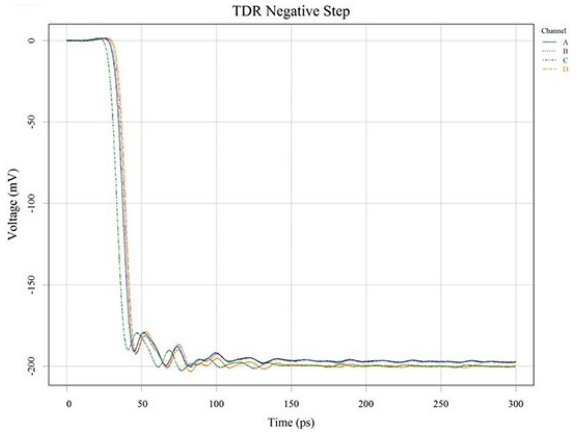


Figure 3. *Options 52F, 52M, 54F, and 54M without TDR Calibration* (Characteristic)

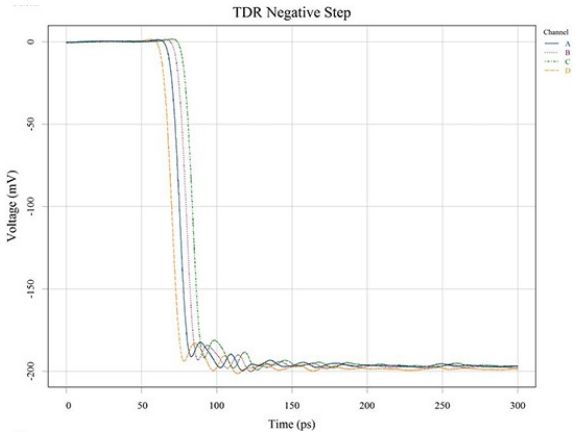


Figure 4. *Options 32F, 32M, 34F, and 34M without TDR Calibration* (Characteristic)

N1055A performance characteristics

Apply when N1055A used with N1010300A signal integrity package for FlexDCA sampling oscilloscope software. Test conditions:

- Mainframe and module have been turned on for at least one hour and have been calibrated
- TDR calibration has been performed using appropriate electronic or mechanical calibration units
- Derived from measurements made on 1.85 mm verification devices that were calibrated by Keysight metrology lab
- Averages of 512 except as noted in dynamic range

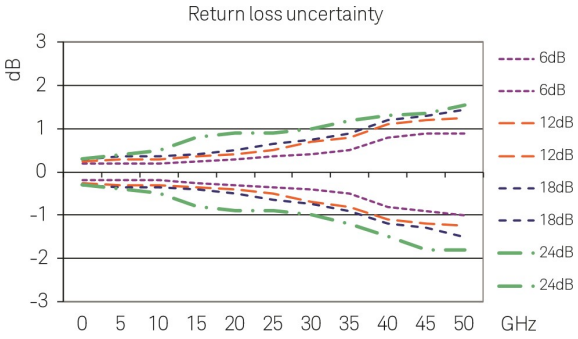


Figure 5. *Return Loss Uncertainty* (Characteristic)

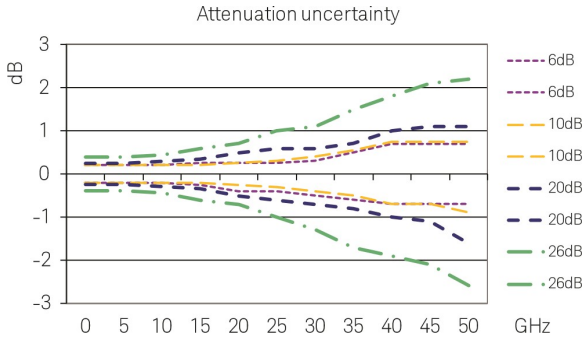


Figure 6. *Attenuation Uncertainty* (Characteristic)

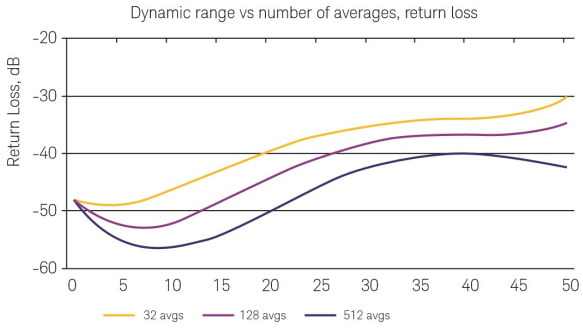


Figure 7. *Dynamic Range vs Number of Averages, Return Loss* (Characteristic)

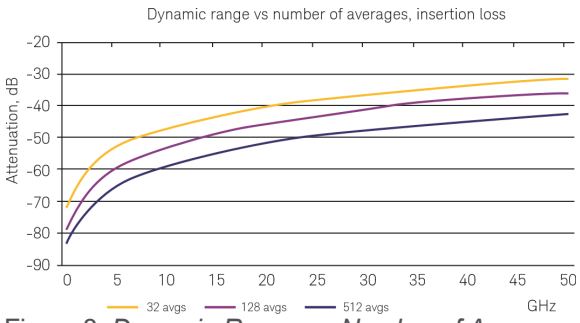


Figure 8. *Dynamic Range vs Number of Averages, Insertion Loss* (Characteristic)

N1060A Module Specifications

N1060A general specifications

Item	Option 050	Option 085
Bandwidth [a], 3 dB (user selectable)	50 GHz	50 GHz, 70 GHz, 85 GHz, and 95 GHz (characteristic)
Risetime (10% to 90%, calculated from TR = 0.35/BW)	7 ps (characteristic)	4 ps (characteristic)
RMS noise		
Characteristic	0.7 mV (50 GHz)	0.7 mV (50 GHz) 1.1 mV (75 GHz) 1.2 mV (85 GHz) 1.6 mV (95 GHz)
Maximum	1 mV (50 GHz)	1 mV (50 GHz) 1.3 mV (75GHz) 1.6 mV (85GHz) 2.0 mV (95GHz)
Scale Factor (per division)		
Minimum	1 mV/division	
Maximum	140 mV/division	
DC Accuracy (V_{AVG} Measurement)		
Specified at calibration temperature ±0.5°C. (Perform a new module calibration if hardware skew has been applied.)	*±2 mV (Characteristic)*	
Specified at calibration temperature ± 5°C.	±2 mV ± 4% of (reading - channel offset)	
DC offset range (referenced from center of screen)	±560 mV	
Input dynamic range (relative to channel offset)	±560 mV	

Maximum input signal	±1V (+10 dBm)
Random Jitter (clock recovery without precision timebase active)	
N1000A-LOJ	< 200 fs (characteristic) at 10.3 GHz, 26.56 GHz.
N1000A-STD	< 400 fs (characteristic) at 10.3 GHz, 26.56 GHz.
Random jitter (clock recovery and precision timebase configuration) [b]	< 80 fs (≥10 GHz) 45 fs (characteristic) at 26.56 GHz 60 fs (characteristic) at 10.3 GHz
Random jitter (external trigger signal applied to precision timebase input) [c]	< 80 fs (≥10 GHz) 45 fs (characteristic) at 26.56 GHz 60 fs (characteristic) at 10.3 GHz
Precision timebase reference input frequency range	2.4 to 32 GHz
Precision timebase reference input amplitude (recommended for optimal jitter performance)	1.0 to 1.6 Vpp (characteristic)
Precision timebase input signal type (The precision timebase performs optimally with a sinusoidal input. Non-sinusoidal signals will operate with some degradation in timebase linearity.)	Sinusoid
Precision timebase maximum input level	±2V (16 dBm)
Precision timebase nominal input impedance	50 ohm
Precision timebase connector type	2.92 mm male
Channel nominal impedance	50 ohm
Electrical Input	1 mm (male) [d]
Channel-to-channel skew range	± 100 ps
Effective trigger-to-sample delay (clock recovery and precision timebase configuration)	< 350 ps (characteristic)

a. Tuned to be –3 dB (± measurement uncertainty) at stated bandwidths, except for 95 GHz which is tuned for highest bandwidth while keeping channel noise ≤ 2 mV RMS.
b. Verified with input signal 1 Vpp @ 10 GHz and 26.56 GHz with 50 GHz channel BW.
c. Verified with input signal 1 Vpp @ 10 GHz, 0.8 Vpp @ 26.56 GHz with 50 GHz channel BW, ~1Vpp to PTB input.
d. Ships with ruggedized 1.0 mm (f) to 1.85 mm (f) adaptors.

Input Impedance Specifictions

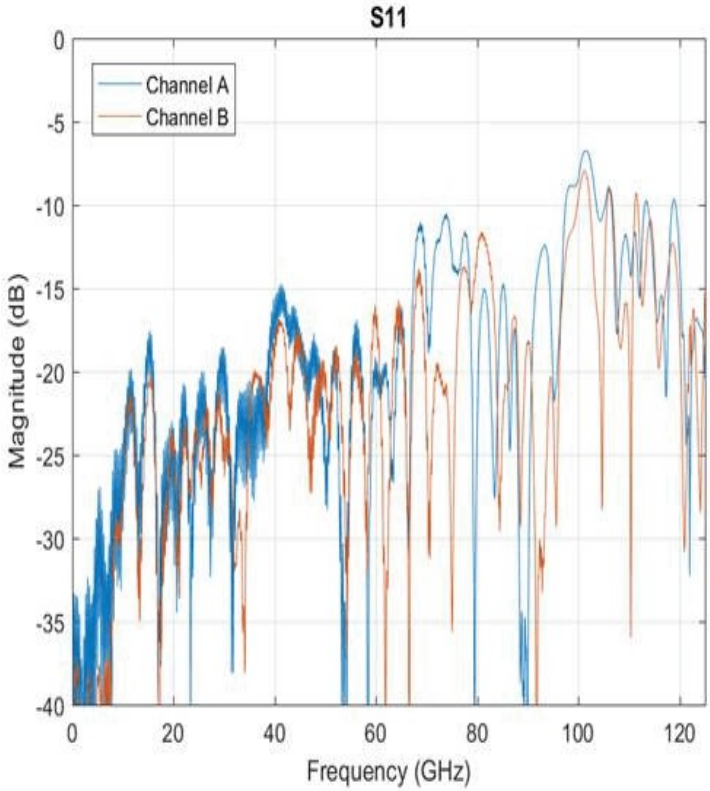


Figure 9. Graph of S11 (characteristic)

N1060A clock recovery specifications

Item	Option 216	Option 232	Option 264
Data rates input range	125 MBd to 16 GBd 125 MBd to 16.4 GBd (characteristic)	125 MBd to 32 GBd 125 MBd to 32.8 GBd (characteristic)	125 MBd to 64 GBd 125 MBd to 65.8 GBd (characteristic)
Clock frequency input range	62.5 MHz to 8 GHz 62.5 MHz to 8.2 GHz (characteristic)	62.5 MHz to 16 GHz 62.5 MHz to 16.4 GHz (characteristic)	62.5 MHz to 32 GHz 62.5 MHz to 32.8 GHz (characteristic)
Minimum input level to acquire lock (NRZ and PAM4, single-ended, open eye)	100 mVpp 30 mVpp at 10.3125 GBd (characteristic)	100 mVpp 30 mVpp at 10.3125 GBd (characteristic) 30 mVpp at 26.56 GBd (characteristic)	100 mVpp (rate ≤53.125 GBd) 200 mVpp (rate >53.125 GBd) 30 mVpp at 10.3125 GBd (characteristic) 30 mVpp at 26.56 GBd (characteristic) 60 mVpp at 53.125 GBd (characteristic) 60 mVpp at 56 GBd (characteristic) 100 mVpp at 64 GBd (characteristic)
Minimum input level to acquire lock (PAM4, single-ended, closed eye)	N/A	200 mVpp at 26.56 GBd with 20 dB channel loss at 13.28 GHz (characteristic)	200 mVpp at 26.56 GBd with 20 dB channel loss at 13.28 GHz (characteristic) 200 mVpp at 53.125 GBd with 16 dB channel loss at 26.56 GHz (characteristic)
Recovered clock random jitter [a]	300 fs maximum ≥2.5 GHz 120 fs at 10.3 GHz (characteristic)	300 fs maximum ≥2.5 GHz 80 fs at 26.56 GHz (characteristic) 120 fs at 10.3 GHz (characteristic)	
Clock recovery adjustable loop bandwidth range (user selectable)	0.015 to 20 MHz (depends on Baud Rate)		
Clock recovery loop peaking range	Up to 4 settings (dependent on loop BW)		

Loop bandwidth accuracy [b, c]	± 30%, (characteristic, NRZ)		
Tracking range (includes spread-spectrum tracking)	± 2500 ppm (± 0.25%), (characteristic, NRZ)		
Acquisition range			
Standard signals:	± 300 ppm, (characteristic)		
Spread spectrum signals:	± 5000 ppm, (characteristic, NRZ)		
Maximum consecutive identical digits to lock	150 (characteristic)		
Auto relocking	Yes (user enabled)		
Jitter Spectrum Analysis (Option JSA)			
Phase noise accuracy	± 30% (characteristic, NRZ)		
Clock Recovery Emulation (CRE) Operating Range (Valid for open-eye signals)	1 — 58 GBd (NRZ) (characteristic)		
	1 — 31 GBd (PAM4) (characteristic)		
Front panel recovered clock amplitude	≥200 mVpp 450 mV at 5 GHz (characteristic)	≥200 mVpp 450 mV at 5 GHz (characteristic) 275 mV at 26.56 GHz (characteristic)	≥200 mVpp 450 mV at 5 GHz (characteristic) 275 mV at 26.56 GHz (characteristic)
Front panel recovered clock divide ratio (user selectable)	1, 2, 4, 8, 16, 32		
Recovered clock front panel connector type	2.92 mm (m)		
Internal frequency counter accuracy	± 10 ppm 4 ppm (characteristic)		

a. Verified by connecting a sinewave to N1060A Channel A, then measuring Recovered Clock signal connected to Channel B (PTB enabled).
b. PLL bandwidth is calibrated and verified using a clean NRZ, PRBS13 signal.
c. Actual PLL bandwidth may vary due to several factors, including pattern characteristics (low/high transition density), signaling format (PAM4), and signal quality (closed eyes).

Modules No Longer Available but Supported by The N1000A DCA-X Mainframe

- N1045A 60 GHz Electrical
- 54752A 50 GHz Dual Channel Electrical
- 83484A Dual Channel 50 GHz Electrical
- 83496A Optical/Electrical Clock Recovery, 50 Mb/s-7.1 Gb/s
- 83496B Optical/Electrical Clock Recovery with Phase Noise Analysis
- 86112A Dual Channel 20 GHz Electrical
- 86107A Precision Timebase Reference
- 86108A Precision Waveform Analyzer
- 86108B Precision Waveform Analyzer
- 86116C option 040
- 86117A 50 GHz Dual Channel Electrical
- 86118A Dual 70 GHz remote sampling head

Ordering Information

The following tables offer helpful information about the DCA-X software, mainframe and plug-in modules and their options but are not intended to serve as a configuration guide.

When configuring a solution, please also refer to the following helpful documents:

- Keysight DCA Wide-Bandwidth Oscilloscope Family Configuration Guide
- Keysight DCA Family FlexDCA Sampling Oscilloscope Software Technical Overview
- Keysight DCA Family Clock Data Recovery Solutions Data Sheet

N1000A DCA-X

N1000A DCA-X hardware options

N1000A	Infiniium DCA-X mainframe
N1000A-PLK	Pattern Lock
N1000A-STB	Standard timebase
N1000A-LOJ	Low jitter timebase
N1000A-PTB	Precision timebase integrated in the mainframe
N1000A-GPI	GPIB card installed (mandatory option)

N1000A miscellaneous options

N1000A-AFP	Module slot filler panel
N1000A-AX4	Rack mount flange kit

N1000A-AXE	Rack mount flange kit with handles
N1000A-UK6	Commercial calibration certificate with test data

N1000A DCA-X hardware upgrade options (if you already own an N1000A)

N1000AU-PLK	Add Pattern Lock
N1000AU-LOJ	Add low jitter timebase
N1000AU-PTB	Add precision timebase integrated in the mainframe

FlexDCA software packages

N1010100A [a]	Research and Development Package for FlexDCA
N1010200A [a]	Manufacturing Package for FlexDCA
N1010300A	Signal Integrity Package for FlexDCA

Application software

SW Application Model	SW Application Description *See the application software datasheet to confirm hardware requirements.*
N109228CA	Electrical TX Test SW for OIF-CEI-3.1
N109310CA	Electrical TX Test SW for SFF-8431 (SFP+)
D9010UDAA	User Defined Application Software (for DCA-X and RT Scopes)
N1091APCA	Electrical TX Test SW for IEEE 802.3ap/bj (10G/40G)
N1091BMCA	Electrical TX Test SW for IEEE 802.3bm
N1091BACA	Electrical TX Test SW for IEEE 802.3ba (40G/100G)
N1091BJCA	Electrical TX Test SW for IEEE 802.3bj (100G)
N1091BSCB	Electrical TX Test SW for IEEE 802.3bs/cd
N109256CB	Electrical TX Test SW for OIF-CEI-4.0
N1095BSCA	Optical TX Test SW for IEEE 802.3bs/cd
N1094BS1A	PAM4 Measurement Software Development Kit.

Optical/electrical modules

86105C	9 GHz optical channel; single-mode and multimode, amplified (750 to 1650 nm) 20 GHz electrical channel
86105C-100	155 Mb/s through 8.5 Gb/s (choose 4 filter rates from Options 86105C-110 through 86105C-195)
86105C-110	155 Mb/s
86105C-120	622 Mb/s (also covers 614 Mb/s)
86105C-130	1.063 Gb/s
86105C-140	1.244/1.250 Gb/s (also covers 1.229 Mb/s)
86105C-150	2.125 Gb/s
86105C-160	2.488/2.500 Gb/s (also covers 2.458 Gb/s)
86105C-170	2.666 Gb/s
86105C-180	3.125 Gb/s (also covers 3.072 Gb/s)
86105C-190	4.250 Gb/s
86105C-193	5.0 Gb/s
86105C-195	6.250 Gb/s (also covers 6.144 Gb/s)
86105C-200	8.5, 9.953, 10.3125, 10.519, 10.664, 10.709, 11.096, 11.317 Gb/s
86105C-300	Combination of rates available in 86105C-100 and 86105C-200
86105C-IRC [a]	System Impulse Response Correction calibration
86105D	20 GHz optical channel; single-mode and multimode, (750 to 1650 nm); filters for 8.5, 9.953, 10.3125, 10.519, 10.664, 10.709, 11.096, 11.317, 14.025 Gb/s; 35 GHz electrical channel
86105D-100	Identical capability as 86105D, 14.025 Gb/s filter not included
86105D-200	Identical capability as 86105D, only filter provided is 14.025 Gb/s
86105D-IRC [a]	System impulse response correction calibration
86105D-281	34 GHz optical channel, filters for 15, 25.78 , 27.95, 28.05 Gb/s (contact Keysight for additional 14.025 Gb/s filter) 50 GHz electrical channel

86115D	20 GHz multi-optical port plug-in module; single-mode and multimode (750 to 1650 nm); filters for 8.5, 9.953, 10.3125, 10.519, 10.664, 10.709, 11.096, 11.317, 14.025 Gb/s
86115D-002	Two optical channels with filters for all rates listed (8.5 to 14.025 Gb/s)
86115D-102	Identical capability as 86115D-002, 14.025 Gb/s filters not included
86115D-142	Identical capability as 86115D-002, only filters provided are 14.025 Gb/s
86115D-282	Two optical channels with filters for 15, 25.78, 27.95, 28.05 Gb/s (contact Keysight for 14.025 Gb/s filter)
86115D-IRC [a]	System impulse response correction calibration
86116C-025	40 GHz optical/80 GHz electrical channels, see specifications for filters
86116C-041	65 GHz optical/80 GHz electrical channels, see specifications for filters
86116C-IRC [a]	System impulse response correction calibration
N1030A-EC1	65 GHz optical/95 GHz electrical channels, see specifications for filters

a. Requires option ETR on 86100D or option PLK on N1000A

Dual/Quad electrical channel modules

N1040A-33	Two 33 GHz electrical channels
N1040A-060	Two 60 GHz electrical channels
N1045B	2/4 port 60 GHz electrical remote head
N1045B-02F	2 channel remote head, 1.85 mm, female
N1045B-02M	2 channel remote head, 1.85 mm, male
N1045B-04F	4 channel remote head, 1.85 mm, female
N1045B-04M	4 channel remote head, 1.85 mm, male
N1046A	100 GHz, 1/2/4 port electrical remote sampling head
N1046A-71F	1 channel, 75 GHz remote head, 1 mm, female
N1046A-81F	1 channel, 85 GHz remote head, 1 mm, female
N1046A-11F	1 channel, 100 GHz remote head, 1 mm, female
N1046A-72F	2 channel, 75 GHz remote head, 1 mm, female
N1046A-82F	2 channel, 85 GHz remote head, 1 mm, female
N1046A-12F	2 channel, 100 GHz remote head, 1 mm, female
N1046A-74F	4 channel, 75 GHz remote head, 1 mm, female
N1046A-84F	4 channel, 85 GHz remote head, 1 mm, female
N1046A-14F	4 channel, 100 GHz remote head, 1 mm, female

Optical channel modules

N1030A	Single 65 GHz optical channel, 9/125 µm fiber input
N1030B	Two 65 GHz optical channels, 9/125 µm fiber input

TDR/TDT modules

54754A [a]	Differential TDR module with dual 18 GHz TDR/electrical channels
N1055A [a]	35/50 GHz, 2/4 port, TDR/TDT remote head
N1055A-FS1	Fast sampling, mandatory option
N1055A-32F	35 GHz, 2 channel remote head, 2.92 mm, female
N1055A-32M	35 GHz, 2 channel remote head, 2.92 mm, male
N1055A-34F	35 GHz, 4 channel remote head, 2.92 mm, female
N1055A-34M	35 GHz, 4 channel remote head, 2.92 mm, male
N1055A-52F	50 GHz, 2 channel remote head, 1.85 mm, female
N1055A-52M	50 GHz, 2 channel remote head, 1.85 mm, male
N1055A-54F	50 GHz, 4 channel remote head, 1.85 mm, female
N1055A-54M	50 GHz, 4 channel remote head, 1.85 mm, male

a. When used in an 86100D, 86100D option ETR is recommended if more than one TDR module is connected to the same DUT

Precision waveform analyzer modules

N1060A-050 [a]	Dual 50 GHz electrical channels
N1060A-085 [a]	Dual 85 GHz electrical channels
N1060A-216	Clock recovery 125 MBd to 16 GBd
N1060A-232	Clock recovery 125 MBd to 32 GBd
N1060A-264	Clock recovery 125 MBd to 64 GBd
N1060A-PTB	Integrated precision timebase (mandatory option)
N1060A-EVA	Integrated variable equalizers in clock path (mandatory option)
N1060A-JSA	Jitter Spectrum Analysis (mandatory option)
N1060A-A1F	Two 1mm (f) to 1mm (f) adapters
N1060A-A1M	Two 1mm (m) to 1mm (m) adapters
N1060A-A1X	Two 1mm (m) to 1mm (f) adapters
N1060A-CA1	Cable pair, 1 mm(m) to 1 mm (f), 160 mm length
N1060A-CA2	Matched cable pair, 2.4 mm(m) to 2.4 mm (m), 24 inch length
N1060A-DC2	Two DC blocks, 2.4mm connectors, 16V, 50 kHz to 50 GHz
N1060AU-085	Upgrade to Option 085 Performance
N1060AU-264	Upgrade to Option 264
N1060AU-232	Upgrade to Option 232

a. 86100D option ETR recommended when used in an 86100D mainframe, N1000A option PLK recommended when used in an N1000A mainframe

External clock recovery solutions

N1076B electrical clock recovery

N1076B-216	Clock recovery range: 125 MBd to 16 GBd
N1076B-232	Clock recovery range: 125 MBd to 32 GBd
N1076B-264	Clock recovery range: 125 MBd to 64 GBd (56 GBd for PAM4 signals)
N1076B-EVA	Integrated variable equalizers (mandatory option)
N1076B-JSA	Jitter Spectrum Analysis

N1077A optical/electrical clock recovery

N1077A-216	Clock recovery range: 50 MBd to 16 GBd
N1077A-232	Clock recovery range: 50 MBd to 32 GBd
N1077A-SMS	Internal SM and MM splitters
N1077A-SXT	No splitter (supplied by user)
N1077A-JSA	Jitter spectrum analysis

N1078A optical/electrical clock recovery

N1078A-216	Clock recovery range: 125 MBd to 16 GBd
N1078A-225	Clock recovery range: 25 to 29 GBd
N1078A-232	Clock recovery range: 125 MBd to 32 GBd
N1078A-253	Clock recovery range: 53 to 58 GBd
N1078A-264	Clock recovery range: 125 MBd to 64 GBd
N1078A-S50	Internal 50-50 SM optical splitter
N1078A-SXT	No splitter (splitter supplied by user)
N1078A-JSA	Jitter spectrum analysis
N1078A-EVA	Integrated variable equalizers in electrical input path (mandatory option)

Warranty Options (for all products)

R1280A	Customer return repair service
R1282A	Customer return calibration service

Accessories

See the *DCA Accessories Guide* for available accessories.

Connectivity Solutions

For a wide range of test adapters to connect to one or more lanes for SFP+, QSFP+, fibre channel, PCIe and many others, please see adapters information from Wilder Technologies at: http://www.wilder-tech.com/. Call Keysight for connectivity and probing solutions not listed above.